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JOURNAL OF MAMMALOGY

VOL. 26 MAY 1945 NO. 2

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The Journal of Mammalogy

Subscription rates, $4.00 per year; single numbers, $1.00 each. Sent free to all members of the American Society of Mammalogists not in arrears for dues.

Subscriptions, changes of addresses, requests for missing numbers, applications for advertising rates, etc., should be addressed to the Acting Corresponding Secretary, William H. Burt, Museum of Zoology, University of Michigan, Ann Arbor, Michigan.

Publications for inclusion in the bibliography ("Recent Literature") of mammalogical literature should be sent to the Chairman of the Committee on Bibliography, Gerrit S. Miller, Jr., Division of Mammals, U. S. National Museum, Washington, D. C.

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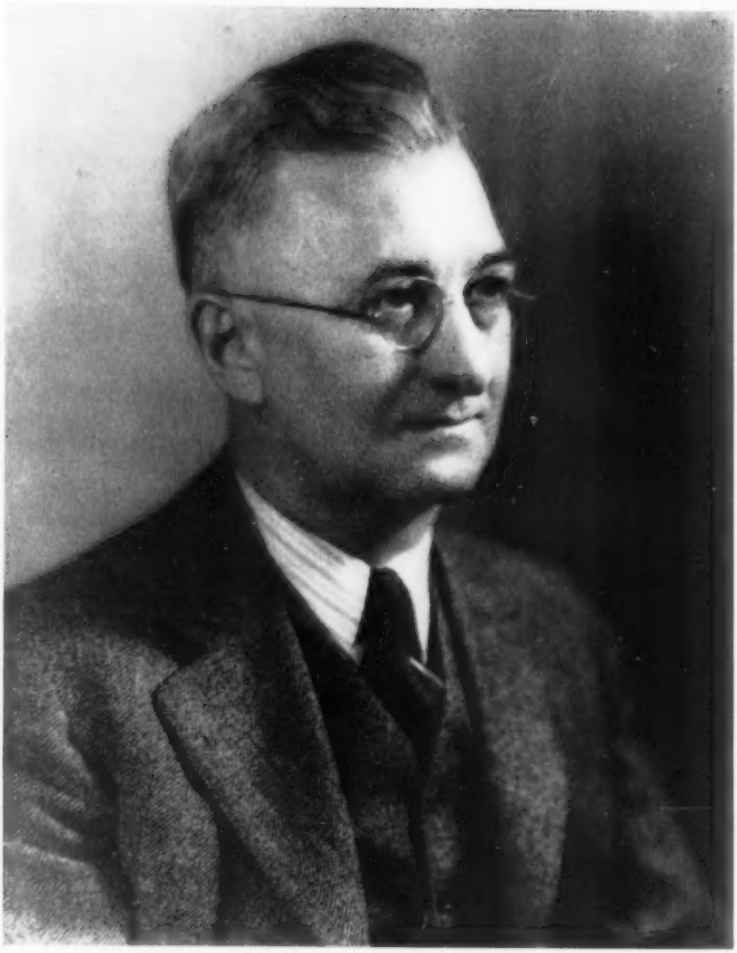
Journal of Mammalogy is published quarterly by the American Society of Mammalogists, Mt. Royal and Guilford Aves., Baltimore 2, Md. Entered as second class matter, November 22, 1919, at the Postoffice, Baltimore, Md., under the act of March 3, 1879.

Made in United States of America



Dan'l Stoner

JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 26 JULY 13, 1945 No. 2

DAYTON STONER—1883 TO 1944

BY L. L. SNYDER

Dr. Dayton Stoner, then state zoologist of New York, died suddenly at his home in Albany on May 8, 1944. Although seriously ill in April, 1943, his health improved and he resumed his work at the New York State Museum in September of that year. The fatal attack was sudden and brief. To one who knew Dr. Stoner, it seems altogether possible that his conscientiousness and strong sense of duty may have driven him beyond the limits of his strength and contributed to the shortening of his life-span to 61 years.

Dayton Stoner's experience as a zoologist was wide and his career varied. His interest, from student days to the time of his death, included many life forms, and therefore he was particularly suited for the post he held in Albany during recent years. Although his studies and publications dealt largely with insects (particularly *Pentatomoidea*) and birds (subjects of many of his most extensive and detailed investigations), mammals received his attention regularly from 1907 to the time of his death. Stoner was a charter member of the American Society of Mammalogists.

Dayton Stoner was born on November 26, 1883, in a small town with a distinctively American name, North Liberty, Johnson County, Iowa. Whether his father, Marcus Stoner, or his mother Nancy (Koser) Stoner, especially directed or encouraged their son in the study of nature, I do not know, but I do know that the environment of North Liberty was not devoid of features which might stimulate his interest in natural history. Although the countryside extending back from the Iowa River is pre-eminently dedicated to agriculture, a considerable and interesting fauna is harbored in its fields, pastures and timbered river-bottoms. There is ample precedent to assume that the native creatures of a boy's environment may serve to excite a curiosity and activate an interest in natural science, often as a life work. One can usually detect in the writings of a naturalist some evidence of such early stimulation—a lingering sentiment, a harking back to boyhood experiences. However, in scanning many of the numerous writings of Dayton Stoner, I find no example of this. His writings are characteristically thorough and detailed, but unembellished by expressions of feeling. Apparently Stoner was ruled rather strictly by two compulsions—one emanating from his personal reserve, the other from his scientific discipline.

From the public schools of his home area, Stoner enrolled in 1903 as a student at the State University of Iowa, which was close by in his native county at Iowa City. There, as an undergraduate and later as a graduate student, he came under the direct and indirect influence of such outstanding natural science teachers as, Calvin, MacBride, Nutting, Wickam, Shimek, Stromsten and Houser. He obtained his B.A. degree in 1907. Continuing his work at the university, making a study of "skulls", he was granted an M.S. degree in 1909.

For the next five years Stoner served as museum assistant at the university. In 1912 he married Lillian R. Christianson, who had been a fellow student at Iowa. In 1913 Stoner served on the Iowa State College (Ames) expedition to Vancouver Island and, although working primarily with insects, he had opportunity to broaden his general zoological knowledge and experience.

In 1914 Stoner was appointed lecturer in zoology at the State University. It was during this period that the writer became acquainted with him, having elected to take his course in ornithology. He was a good lecturer, lucid and methodical. Though always serious about his work, he did not ignore the lighter side, and recognized the high value of introducing his students to living animals out-of-doors. We made several trips afield early on spring mornings. Opportunity was thus afforded to acquire a little more personal contact with Stoner himself. On such walks Stoner's reserve melted like the skin-deep frost on ploughed Iowa fields in March. Thoughts of his amiability have clung to my mind as did the Iowa soil to our hiking boots. To dress in field togs and lay aside the decorum of the classroom in favor of a companionable walk in the woods and fields is a method that can be recommended to all teachers of biology.

In 1919 Stoner received his Ph.D. degree at Iowa. His thesis was on the *Scutelleroidea* of Iowa, but during the same period he had prepared another contribution better known to mammalogists, namely, "The Rodents of Iowa". This latter work has had wide and practical use and is still a valued reference book in the mid-west and elsewhere. During the remainder of the time he served the University of Iowa (as Associate, 1919–20; and as Assistant Professor, 1920–28), Stoner had opportunity for a variety of experiences in the field, in laboratories and on expeditions. He taught at the Okoboji Lakeside Laboratory in Iowa during the summer of 1916 and at the Douglas Lake Biological Station in Michigan in 1919 and 1920. In 1918 he was a member of the university's expedition to Barbados and Antigua and in 1922 he made his longest field trip, another university enterprise, visiting Fiji and New Zealand.

Leaving the university in 1928, Stoner joined the staff of the United States Bureau of Entomology as field assistant. He continued in this capacity for three years. In 1932 he accepted the post at Albany, a work for which his training, interests and experience especially fitted him. Here he had opportunity to carry on researches in the several fields of his interests, to write as a teacher sincerely concerned with the ideals and purposes of education, and to widen his contacts with scientific workers. His accomplishments and usefulness grew steadily and this makes more poignant his untimely passing.

Dayton Stoner made an admirable contribution to knowledge. He never lost an opportunity to gather useful facts. As an example of how he utilized every occasion to harvest detailed data, one has but to recall his numerous and orderly records of animals killed on highways, a by-product of his travels. No less than 14 titles in his complete bibliography deal with the mortality of animals as observed on highways.

It is here fitting and proper to record, as did Dayton Stoner on numerous occasions, the full and able assistance he received from his wife, who survives him in Albany. She was companion, aid and co-worker in many of his enterprises, and a zoologist in her own right.

It is difficult to summarize the characteristics of a man or evaluate his work. Rather sporadic contacts with Dayton Stoner revealed him to me to be especially conscientious and conservative. Caution guarded him against unestablished procedures. No one could have been more anxious to have statement strictly in accord with fact. His joy came from his work which was voluminous and well done. He possessed geniality although it was usually covered by formality and reserve. He followed the progress of his former students with special interest. Anyone who had contact with him as state zoologist, particularly inquiring correspondents, found him always willing and helpful. He will be missed by many men although he had few intimates.

Stoner's published books, papers and notes run to 163 titles. Fifteen of these dealt entirely or principally with mammals. An additional six papers are in press, two of which concern mammals. Stoner's published works on mammals are listed below:

1917. Notes on some Iowa rodents. Proc. Iowa Acad. Sci., vol. 24, pp. 353–356.
1918. The rodents of Iowa. Iowa Geol. Surv. Bull., no. 5, 172 pp.
1920. An unusual example of incisor growth in the western fox squirrel. Proc. Iowa Acad. Sci., vol. 25, pp. 105–110. (1918)
1922. Another tree-climbing woodchuck. Jour. Mamm., vol. 3, no. 4, p. 260.
1925. The toll of the automobile. Science, vol. 61, no. 1568, pp. 56–57.
——— The star-nosed mole in Minnesota. Jour. Mamm., vol. 6, no. 2, p. 125.
1929. Automobiles and animal mortality. Science, vol. 69, no. 1800, pp. 670–671.
——— Speeding motor cars take toll of wild life. U. S. Dept. Agric. Clip Sheet, no. 563, p. 2.
1935. Highway mortality among mammals. Science, vol. 81, no. 2104, pp. 401–402.
1936. Wildlife casualties on the highways. The Wilson Bulletin, vol. 48, no. 4, pp. 276–283.
1937. The house rat as an enemy of the bank swallow. Jour. Mamm., vol. 18, no. 1, pp. 87–89.
1938. New York state records for the common dolphin, *Delphinus delphis*. New York State Museum Circular no. 21, 16 pp.
1939. Remarks on abundance and range of the opossum. Jour. Mamm., vol. 20, no. 2, pp. 250–251.
1940. The Canada porcupine as a highway casualty. Jour. Mamm., vol. 21, no. 3, pp. 360–361.
1943. Cottontails and jackrabbits on the turnpike. Nature Notes, vol. 9, no. 5, pp. 50–51.

Royal Ontario Museum of Zoology, Toronto, Canada.

A PARTIAL HISTORY OF THE ELK HERDS OF COLORADO[1]

By Lloyd W. Swift

The reestablishment and present general distribution of the Rocky Mountain elk (*Cervus canadensis nelsoni* Bailey) in the mountain areas of Colorado is a development of the past two decades. Before the period of exploration and during the early efforts at settlement, the elk were common and free to roam over their chosen range. But man altered this, by usurping the valleys for farms and by persistent and unregulated hunting, reduced the herds, and caused the survivors to retreat to the protection of the higher mountains.

Mining expansion brought thousands of people to the mountain areas so, during the heyday of Leadville, Ouray, Creede and many another mining town, there was hardly a part of the Colorado Rockies that was not subjected to scrutiny by prospector or promoter. Associated with all this was the hunter who was unhindered by game laws and encouraged by a belief that there was plenty of game for all. By the time the rush of development had subsided and the people of the State had more time to inventory their wildlife and other resources, some species were nearly exterminated. Thus, even as late as 1910, there was good reason to suspect the eventual extermination of the Rocky Mountain elk.

THE RETURN OF THE ELK

From neglect of the welfare of wildlife, there was a steady and determined effort directed toward its restoration. Game laws gradually became more restrictive until closed seasons were established by the legislature from 1913 to 1918 on deer and from 1913 to 1929 on elk. Then during the period 1910–20 a vast system of refuges was created, and about the same time elk were reintroduced by shipments from the Jackson Hole and northern Yellowstone herds.

Before considering the individual herds, it would be helpful to summarize the past 30 years of elk resurgence in Colorado. No accurate figures are available, but from the records of the Forest Service it appears that the native elk herd was probably between 500 and 1,000 in 1910. These survivors were in about 10 small bands, scattered in wilderness territories in the mountain areas, with the largest numbers in the headwaters of the White and Gunnison rivers.

Coloradans who had known of the general occurrence of elk in the late 80's, realized that the herds could be restored. To hasten their return, interest was created in planting elk, and over the period 1912 to 1928 fourteen introductions totaling about 350 elk were made. Most of the plantings were of about two dozen animals. Except for the Ouray planting of 1922 and that at Ridgeway in 1928, plantings were all made between 1912 and 1920, with half of all releases

[1] The material on introductions and relict native herds here reported was obtained from a report prepared in 1932 by the late John H. Hatton, who was for many years Chief of the Division of Range Management in the Forest Service at Denver and, prior to his retirement in 1941, Assistant Chief of the Division of Wildlife Management in the Chief's Office, Washington, D. C.

in the three years 1913 to 1915. Most of the imported elk were turned out in areas where the native species had been extirpated. With the exception of Pike's Peak and the Wet Mountains, the introduced elk have made good increases, which in itself indicates the unsuitability of these two regions for elk under prevailing patterns of land use.

The return of the elk has been much more successful than most persons appreciate. From about 25 foci of native and planted elk, totaling not much more than 1,000 head, the elk are now common over most of the wild and mountain country of the state. The 1943 estimate for the state was 24,000 elk. Thus in 30 years Colorado has seen its elk population spring from near extermination to abundance. The need for protection through refuges, closed seasons and other restrictive measures is largely past. Hereafter the emphasis must be on utilization and management rather than restoration.

Estimated population and increases present an important side of the elk history. The availability and condition of the range, however, is the factor that determines the desirable limits in distribution and quantity. In several places, elk are now in excess of the natural food resources, and are inflicting damage to the plant and soil values as well as making depredations on agricultural areas. In these cases, herd control is a part of a sound big game program, and antlerless as well as antlered animals should be removed. This is the present management policy of the Colorado Game and Fish Department.

HISTORY OF INDIVIDUAL ELK HERDS IN COLORADO

South Platte Drainage.—The native elk were believed to be nearly extirpated in the Estes Park and adjacent Front Range country by the turn of the century, so a concerted effort was made to reestablish the species through introductions. This resulted in the stocking of two general areas—the Upper Big Thompson drainage at Estes Park and the Boulder Creek territory at Nederland and Rollinsville.

The first releases were made in the Estes Park area—25 head in March 1913, and another 25 head in April 1914, the animals being shipped to Lyons and trucked to Estes Park. These elk did exceptionally well and received protection from the formation of the Rocky Mountain Park in 1915, and later by a State Game Refuge in the foothills to the east. Through the years, this herd of elk has increased and spread into adjacent areas. Protection, however, has been too rigidly applied, and the elk have in recent years caused much damage to private lands and to the native forage in the National Park. The special season of 1941 on National Forest and private lands was an attempt to remove a part of the excess population; the 1942 season eliminated an additional one hundred.

Apparently 3 of the 1913 elk destined for Estes Park were taken to Nederland, but the principal plant of 25 was made in 1915. The stocking in the area was subsequently supported by a shipment of 47 to the Rollinsville territory in 1917. Although more elk were brought into the Boulder Creek drainage than to Estes Park, the herds have never prospered. Perhaps a large elk herd in the area would be undesirable, since there would certainly be constant conflict with agricultural interests.

In 1914, 20 cows and 5 bulls were brought from Jackson Hole and released in the vicinity of Idaho Springs. These elk became established in the Mt. Evans area and eventually the main herd developed on the Bear Creek drainage. Because of the recreational use of Mt. Evans, the summer home and park development in the Denver Mountain Parks, and the blanketing State Game Refuge, this herd was not subjected to hunting until 1942. The present herd of some 1,500 is somewhat in excess of the food resources of the range and damage has occurred on National Forest and private lands, particularly on Bear Creek.

Arkansas Drainage.—In sharp contrast to the successful establishment of elk on the Mt. Evans area are the poor results realized from a plant of 45 head on Pike's Peak in January 1916. Since Pike's Peak forms an island in a circle of more or less continuous series of communities, the elk were never remote from man. Consequently, it is believed that persistent poaching has prevented an increase; even now the herd is reported to be about 20 head. From most viewpoints it is perhaps fortunate that the Pike's Peak herd has not succeeded. The range is definitely limited and damage to ranches and the National Forest lands would result. Because the city of Colorado Springs watershed is involved, public hunting over the lands might be undesirable. Moreover, the soil is highly unstable, being course and granitic, and would readily erode if the protecting mantle of vegetation were unduly disturbed.

Probably one of the first mountain areas in Colorado to lose all its native elk was the Wet Mountains and the Sangre de Cristo. In 1916 the two elk that had escaped from a private herd were believed to be the only ones on the San Isabel National Forest (now about 25 head). During that year 22 head were brought from Jackson Hole and turned out at Beulah and Rye. The range is too limited for elk, it being impossible for the animals to retreat to a large wilderness back country where they would be free from constant interference by man.

Ten head of elk were brought from Steamboat Springs and released in the Twin Lakes area in 1920. The herd has increased slowly and now probably numbers 110, and for the most part is confined to the mountains above Twin Lakes.

Rio Grande Drainage.—The once numerous elk of San Luis Valley were deprived of this good range area when the land was taken for settlement. Most of the elk were killed, but small groups retreated to the upper reaches of Saguache Creek and the Rio Grande drainages.

The Saguache herd has made a great recovery. From an estimated 25 head in 1905 the herd multiplied to about 1,500 in 1940. The main elk range is in the Saguache Creek drainage and the herd often winters in Saguache Park. Their range also includes the Los Pinos headwaters and, in summer, portions of the band cross the La Garita range and feed on the Rio Grande side. This herd has added to the forage demand on the National Forest lands, and in severe winters the elk have invaded the ranches on Upper Saguache Creek. Heavy hunting in recent years has resulted in the spread and reduction of this herd.

The Rio Grande herd found asylum in the Goose Creek area to the south of Wagon Wheel Gap. Estimated at less than 100 in 1907, the elk have made

a steady comeback and for the Rio Grande National Forest the present estimate is now 1,400. The herd centers in the Goose Creek area where local overstocking is evident despite the reservation of a large acreage of public range for the herd.

San Juan and Dolores Drainages.—Part of the Goose Creek herd is believed to have strayed over the Continental Divide to form the present elk herd at the head of the San Juan River. These elk are increasing and are now fairly well distributed in a rather rough and wilderness-like country. The Upper San Juan drainage should support a large herd, but it may be difficult to accomplish good herd management because of the isolated and rough character of the country.

The 30 or so elk hiding in the rough country of Hermosa Creek in 1910 were given new blood through an introduction of 23 Yellowstone elk in 1912. The elk confined their expansion for the most part to the Hermosa Creek drainage. It was with some surprise then that the herd was discovered to be up to about 1,500 when counted from an airplane in 1940. Since then considerable damage has been noted to National Forest ranges, and the elk have also invaded some agricultural areas on the Los Animas River. Herd control has been undertaken by open seasons including the taking of a limited number of females.

Some of the Hermosa elk crossed the Divide to the Dolores River drainage where they became associated with a few native animals. These have not made rapid increases, although the present estimate on the entire Montezuma National Forest is 1,500. Unless hunting is sufficient to provide local control in future years, overstocking can be expected in a short time.

Gunnison Drainage.—Some native elk were able to persist in the mountains at the head of the Gunnison River, particularly in the drainage basins of Coal and Soap creeks. Closed seasons rescued these survivors and they were added to by some drift from the plantings at Aspen. From an estimated 200 in 1911, the herd developed and spread rapidly, but particularly in the Soap Creek area where 800 head were counted on the winter feed ground in 1941. The Gunnison National Forest now reports 6,000 elk and, therefore, probably has the greatest concentration of this species of big game in the State. In the Sapinero area the elk are much too numerous for the native food resources and an expensive feeding program has been supported by the State for a number of years. Despite this, many elk do not survive the winter and the unsatisfactory situation is intensified by further damage to an already injured range. Furthermore, as the elk overran the range, deer have found the competition for food too severe and have decreased on Soap Creek.

The present elk herds in the Muddy Creek and related drainages on the North Fork of the Gunnison have always been loosely tied into the main Gunnison herd. It is believed that some native elk provided a remnant on the Leroux Creek area and these, plus additions from the North Fork of the Gunnison and Crystal River territory, contributed to the estimated herd of 300 now reported for the Grand Mesa National Forest.

There were no remnants left to provide a nucleus of elk in the Uncompahgre River area so plantings were made at Ouray in 1922 and at Ridgway in 1928.

Both herds increased and spread until their territories now overlap. The Ouray herd has long been famous as common visitors to the town, and has even been enrolled on the membership of the local Elks Lodge. A portion of the Ouray herd has been fed during winter periods for many years. The Ridgway, or Plateau, herd has now reached out into the farming area and damage has been experienced from depredations to stacked hay. The combined herds total about 500 individuals.

Colorado Drainage.—The Middle Park elk herd was fairly accessible to the hunters and was reported to be down to about 50 head in 1913. From this small number the herd benefited from closed seasons and the Williams Fork Refuge until it expanded and caused damage to local ranches. The refuge was opened in 1929 and about 300 killed. Since then the elk have been in conflict with some of the established livestock industry and there have been open seasons most of the years. The State Game Department has fed part of two small herds, one on Beaver Creek and the other on the Troublesome since 1930, but this practice was discontinued in 1943.

The elk of Eagle River and the Roaring Fork were probably all gone by 1903, despite statements of a possible population of 6,000 to 8,000 in the early 80's. Through efforts of the Elks Lodge at Aspen, 62 head were introduced over a three-year period from 1913 to 1915. These plantings were successful, the elk increased in numbers and extended their range. Today the estimated population on the Holy Cross National Forest is 1,700. Some areas could support more elk, but on certain territories, such as the Thompson Creek drainage and the triangle between the Frying Pan and the Roaring Fork Rivers, the forage is showing elk damage.

White Drainage.—The largest group of native elk to remain for replenishing the state's supply was found in the headwaters of the White River, in the White River National Forest. In this large roadless area, natural factors of isolation and ample food and cover combined to give the elk more protection than was afforded on other portions of their ranges. Closed seasons gave further assistance and in time the White River area became the center of one of the largest elk herds in Colorado. In recent years it has probably yielded the most elk hunting. During the last decade, excess populations have developed in several local areas, but especially on the South Fork. The opening of the ½-million-acre White River State Game Refuge was necessary in 1939 and beginning in 1941 a limited harvest of female elk was also permitted. Perhaps the White River area could continue to support the present elk population of around 2,300. Certainly any proposed increase on the North and South Forks should be given careful consideration.

Yampa Drainage.—Routt County was famous as an elk country in the early days, one estimate for 1880 being 20,000. Market hunting undoubtedly took its toll, and by 1912 the herd was reported to be reduced to 120 individuals in the territory included in the Routt National Forest. From this nucleus of native elk the herd has gradually expanded until it is now approximately 800. In the meantime, hunting has been permitted during most years since 1929 so that the

herd has been contributing to the recreational values of the State. Some conflict has been experienced, particularly depredations to hay stacks, but through stockade enclosures for hay and some supplemental feeding the damage has been largely corrected. As a management objective the herd should probably be held to its present size.

SUMMARY

The history of the Colorado elk herds illustrates the ability of this species of big game to become reestablished where range is available and protective measures are applied. It shows that elk populations can be increased readily under a restoration program and therefore allays the concern expressed over the possibility of overshooting under present limitations of seasons, bag limits, and other restrictive measures.

The further application of management principles can be expected to keep the herds in adjustment with the environment. At the present time, it is the opinion of the Colorado Game and Fish Department that there are now only a few elk problem areas in the State. On all problem areas the number of antlerless licenses have been increased considerably and marked progress has been made in adjusting numbers to the carrying capacity of the range.

U. S. Forest Service, Department of Agriculture, Washington, D. C.

THE HOME RANGE OF SOME BRAZILIAN MAMMALS

By David E. Davis

Studies of the movements of individual mammals have shown that in general each individual remains in a limited area for a considerable period of time, often for many months. For mammals, the term home range is used to mean the area in which the individual lives. For other vertebrates, notably fishes and birds (Nice, 1941), the word territory is used to mean an area that is defended by the individual. Until a species of mammal can be adequately studied to determine whether it actually defends the area in question, the use of the more general term, home range, is advisable even though in many cases the home range appears to be a true territory. The recent summary by Burt (1940) brings together the information concerning the home range and territory of temperate zone mammals, principally rodents. However, little is known of the movements of tropical mammals except for the extensive studies of Carpenter (1934, 1935, 1942) on monkeys.

The purpose of this paper is to record some observations on the home range of a few tropical mammals. The investigations of the movements were not organized to study the home range in detail but were part of a coordinated investigation of the ecology of Brazilian forests in connection with jungle yellow fever reported in detail elsewhere (Davis, in press).

The region in which the study was made is in the county of Teresópolis in the State of Rio de Janeiro. This county is situated on the top of the coastal range

at an altitude of above 800 meters; some peaks reach 2,000 meters. The topography is rolling, with narrow flat margins along the creeks. The hilltops are more or less covered with forest or brush, and the valleys are extensively cultivated. There is no virgin forest except along the slopes of the coastal range. The trapping was done from August 1942 to September 1943 in an area of second-growth forest (research area, fig. 1) on Fazenda Boa Fé.

The work on which these observations are based was done under the auspices of the Serviço de Estudos e Pesquisas sôbre a Febre Amarela (Yellow Fever

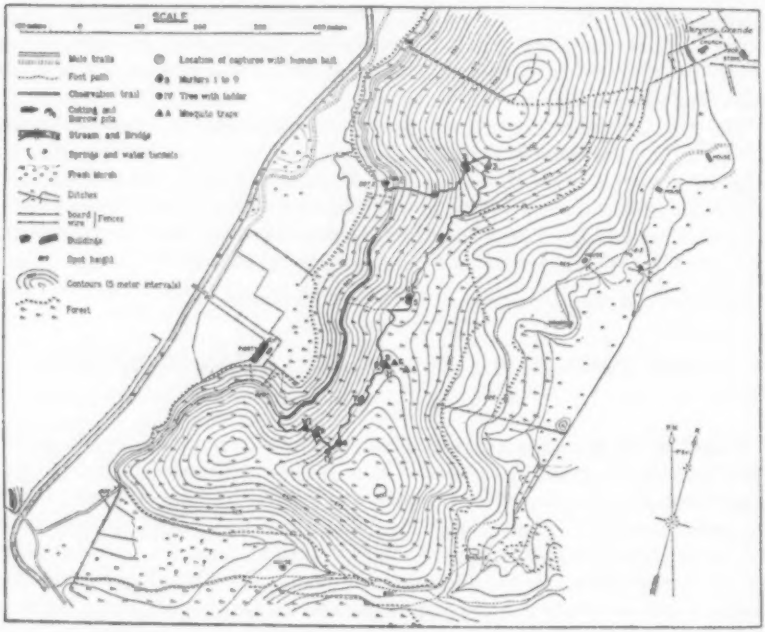


FIG. 1. Map of the research area showing the trail, the locations along the trail (Arabic numerals), and traps in trees (Roman numerals).

Research Service) which is maintained jointly by the Ministry of Education and Health of Brazil and the International Health Division of The Rockefeller Foundation.

METHODS

Monthly visits of 8 to 10 days duration were made to the forest. For the investigations of the movements of the individual mammals, a line of 30 traps was set out along a trail (fig. 1). The numbers on the map refer to locations on the trail approximately 100 meters apart. Decimal fractions are used to indicate spacing between the numbered locations. Thus, location 1.5 is half

way between location 1.0 and location 2.0. Each month traps were set between locations 1.0 and 3.5 and 5.3 and 9.0. In addition, during the months of October, February and June a line of kill traps was placed at the base of the hill in the

TABLE 1.—*Captures and Recaptures of Didelphis marsupialis*

INDIVIDUAL	AGE	SEX	LOCATION OF CAPTURE											
			1942					1943						
			AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY
M 14658	Adult	♀	1.5 2.2 2.8	2.8 3.2 1.5	1.5 4.8 4.8 2.2	3.5 1.5	1.5 2.5	1.5	1.5		1.5	1.5	1.5	
M 14669	Adult	♀	5.6 5.1		X 5.3 9.5			5.4						
M 14909	Adult	♂			9.0									
M 14993	Adult	♂				9.5								
M 15001	Adult	♂				5.3								
M 15085	Adult	♂						7.7	X					
M 15096	Immature	♀						9.4 9.4	X			7.6 9.2	8.2	
M 15137	Young of M 14669	♀						5.4		4.9	2.5 2.2	1.6 3.8 4.2	1.6	
M 15319	Adult	♂									7.8	6.0	9.0	
M 15422	Immature	♂										6.0		
M 15541	Adult	♂											1.0	
M 15542	Adult	♂											4.3	
M 15564	Adult	♀												2.9
M 15570	Adult	♂												2.7

forest between the pigsty and house. The traps used for live trapping the small mammals were made from a snap trap and a tin can. For the larger mammals collapsible wire traps were used. Very few individuals were killed, although on cold nights some mice succumbed. Except under special circumstances no

mammals were removed from the area. The individuals were numbered by cutting off toes. Unfortunately, pressure of other work prevented the use of more than 30 traps or of a grid system of trapping, which probably would have furnished more detailed information. While these methods do not give the detailed results desirable in an investigation of the home range, nevertheless the information thus obtained provides considerable advance in the knowledge of the behavior of some tropical species.

HOME RANGES

The forest at Fazenda Boa Fé contains several species of marsupials. Two species, the common opossum (*Didelphis marsupialis*) and the woolly opossum (*Caluromys philander*), were present in sufficient numbers for observations on the home range. In addition, a species of masked opossum (*Philander opossum*) was represented by individuals that wandered through the areas, especially in April and May. A few individuals of the murine opossums (*Marmosa agilis*, *Monodelphis scalops*, and *Monodelphis americana*) were captured, principally in September and October.

The captures and recaptures of the opossum *Didelphis marsupialis* are listed in Table 1, according to location. The trapping, marking and releasing of individuals began in August 1942, but in the month of July several individuals were trapped and removed from the area. A total of one adult male, two immature males, one adult female and one immature female was removed. After the month of July no opossums were removed from the area until June, when all that were captured were taken away.

Comparison of Table 1 and figure 1 shows that the females remained within a small area for a long period of time. Individual M 14658, a female, stayed between locations 1 and 5 for 11 months and then was removed from the forest. During the latter months no trap was set near station 4.8, but it is likely that she wandered into that section as she had done in the first few months. The males, on the other hand, were seldom recaptured. Three individuals released in October and November were never recaptured, although one released in April was caught in the next two months. The individuals captured in June and July were removed from the forest but are noted here to indicate that some individuals entered the area.

During the months of October, February and June, one adult female was captured in about the same place in a trap line that was located along the edge of the forest below the hill roughly between the pigsty and the house. In addition, she was captured in May in a trap line at the top of the hill at stations 6.0 and 4.8, which were directly above the places of capture at the base of the hill. Some of the opossums originally trapped on the upper trap line were caught also on the edge of the forest. In addition, in October one adult (sex unknown) and one adult female were captured, but never recaptured. In June one immature female and in July two adult males were caught.

Some young individuals were marked while still in the pouch. In August at location 5.6 seven young were marked and put back in the pouch of M 14669.

Only one of these, a female (M 15137), was recaptured. As shown in Table 1, she was recaptured near where her mother had lived and remained near there until she was taken out of the forest in June. Seven young of another female, captured in the trap line on the edge of the forest, were marked and returned to the pouch, but none was ever recaptured.

The differences between the sexes in the amount of movement is marked. The two adult females and two immature females were all recaptured over a period of several months. In contrast, of the five adult males released only two were captured a second time.

TABLE 2.—*Captures and Recaptures of Caluromys philander*

INDIVIDUAL	AGE	SEX	LOCATION OF CAPTURE												
			1942					1943							
			AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	SEPT.
M 14674	Adult	♀	9.2 9.0 9.0								9.0				9.0
M 14680	Adult	♀	8.1	9.2 9.0	9.0 9.0 9.2 9.0	9.0 9.0 9.2 9.2	9.2 9.0	9.0	9.2 8.1	9.0		9.2		8.1	
M 14895	Adult	♂			4.9 9.0			4.9							
M 15119	Adult	♀						4.9			4.9	4.9			
M 15228	Immature	♀								9.0 8.1				6.0	
M 15325	Immature	♀									6.0				
M 15326	Adult	♂									9.0	9.2	9.0		
M 15530	Adult	♂									6.0				

A more complete study (Lay, 1942) of the opossum in Texas, which is considered by Gilmore (*cf.* Bugher et al., 1941) to be conspecific with the Brazilian opossum, showed similar results. About half the individuals were never retrapped, but some remained in the same area for many months. Also, as was true in Brazil, the ranges of individuals overlapped in many instances. However, in contrast with the results in Brazil, the females wandered as much as the males.

The arboreal woolly opossum (*Caluromys philander*) was captured several times in traps set on platforms in the trees. Table 2 shows the locations of the

captures of the individuals. During the month of July one adult male and one immature male were removed from the area but no other individuals were taken out of the forest until July.

The three adult females were captured repeatedly in the same place. A comparison of the location of captures of two females (M 14674 and M 14680) is noteworthy. The former seems to have moved out of the area around station

TABLE 3.—*Captures of Mice*

FAZENDA BOA FÉ		AKODON ARVICULOIDES	AKODON NIGRITA	THOMASOMYS SUBLINEATUS
Individuals released		64	64	27
Individuals not recaptured		20	35	18
Individuals recaptured		44	29	9
Individuals recaptured in more than one month		24	21	8
Individuals dead in traps		22	21	10
	Distance in meters	Times recaptured		
Frequency of recapture at a distance from location of original capture	0	19	14	4
	10	12	6	3
	20	8	5	1
	30	16	5	2
	40	10	4	2
	50	6	1	1
	60	3	1	0
	70	4	0	0
	80	2	0	1
	90	4	0	0
	100	1	2	0
	110	1	0	1
	120	2	1	1
	130	0	0	0
	140	1	2	0
	150	0	1	0
	160	0	1	0
	180			1
	220	1		
	260			1
	400	1		
Totals		91	43	18

9 after August, but to have returned in April and again in September, after M 14680 had been removed. It is possible that the two traps were on the boundary of the home ranges of the two individuals. The adult male M 14895 traveled in the month of October from station 4.9 to 9.0 in two days. The immature female M 15228 also traveled considerably between March and July. As in the case of *Didelphis marsupialis*, the females tend to remain in the

same place for longer periods than the males. However, the individuals of both sexes appear to travel but little in the forest.

Three species of small rodents were recaptured regularly and a sufficient number of times to permit discussion of the home range of individuals. All three are forest mice and are strictly terrestrial. Table 3 shows the number of individuals released, the number found dead in the traps, the number not recaptured, and the distances from station of original capture. Distance 0 means that the individual was recaptured at the point of original capture. Distance 40 means that the individual was captured approximately 40 meters along the trail (not necessarily in a straight line) from the point of original capture.

The species *Thomasomys sublineatus* is a large, active, slightly subterranean mouse. It is less common in the forest than the other species. As shown in Table 3, 18 individuals were released but not recaptured, and 9 individuals were recaptured a total of 18 times. It will be noted in this table that usually the individual was captured near the place of original capture. In only two instances was an individual captured more than approximately 150 meters from the site of original capture. One individual was captured four days after release at a point 180 meters by trail, but actually about 60 meters in a straight line, from the site of original capture. Another was captured 260 meters by trail from the point of release but actually only 120 meters in a straight line. These individuals were captured in nearly the same place for several months.

The species *Akodon arviculoides* was the most common rodent in the forest. As shown in Table 3, many individuals were recaptured at the original site. In only a few instances were mice captured at a distance of more than 100 meters, along the trail, from the place of original capture. One subadult female (number 7) was captured on September 10 at station 3.5; on September 16 she was caught at station 7.5, which was about 375 meters in a straight line from the location of original capture. The next month (October 10) she was found dead in the trap at station 5.7. She was the only individual recorded more than 140 meters away from the location of original capture. Individuals were recaptured repeatedly in nearly the same locality in succeeding months. Some notable examples are numbers 24 (October to February), 31 (October to January), 51 (February to June), 59 (February to May) and 111 (October to January).

The species *Akodon nigrita* resembles its larger congener but is more subterranean and more diurnal. As shown in Table 3, no individual was recaptured more than 160 meters by trail from the site of original capture. Some individuals were recaptured in the same place for several months as, for example, numbers 23 (November to January), 24 (November to June), 26 (November to February), 27 (November to January) and 33 (January to June).

The evidence obtained from trapping along a trail in the forest shows that the mice were recaptured near the place of original capture. Except in rare instances, no individual was found more than 150 meters in a straight line from the original place. Furthermore none of the 25 specimens, which were captured in the trap line at the base of the hill, was marked. While it is true that the best manner in which to study the home range is to set traps in a grid, nevertheless

it seems likely that the straight line of traps indicates the range of movement. It seems reasonable to state that if the individuals regularly moved considerable distances, several, at least, would be captured a long distance from the site of original capture. Evans (1942) found that two species of English mice restricted their activity to a home range of 100 yards and 60 yards, respectively. It will be noted in Table 3 that many individuals were never recaptured. It may be suggested that these individuals traveled long distances and were therefore not trapped again. However, it seems likely that a large proportion of these individuals died shortly after release. Many individuals were set free in a weakened condition due to being kept in the trap for many hours; it should be noted that many individuals were found dead in the traps. Furthermore, the number of traps was small. Considering the short life of small rodents, it does not seem unreasonable that many individuals were never recaptured. Examination of the sex and age of the individuals not recaptured does not reveal any differences in comparison with the entire group. Evans (1942) found that about one-half the population disappeared within one month after first capture.

TABLE 4.—*Number of Bats Captured*

SPECIES	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	SEPT.
Carollia perspicillata	(1)	1 (2)	9 (1)	3	1	1	1 (5)	2	1	2	7		1	
Desmodus rotundus	1	2	1				2	1	1		4		7	8
Anoura geoffroyi	4	1	10				3	3	1	1	6	1		

Some observations concerning the movements of three species of bats are also included. Table 4 lists the captures of three species. The bats were collected on one day each month in artificial tunnels dug in the hillsides. In addition some individuals of *Carollia*, as indicated by numbers in parentheses, were captured in snap traps baited with banana.

In all three species the number present in the tunnels decreased in the months of October, November and December, but during the rest of the year some bats were regularly captured in spite of the fact that all individuals captured were killed each month after November. Apparently the bats either moved out of the tunnels or no bats came into them from other areas during those three months. The constant capture of bats in the remaining months of the year indicates that some individuals were moving into the tunnels from other places.

In the months of September, October and November some bats were banded and released. Of the nine individuals of *Carollia perspicillata* which were released in September, one individual was recaptured in a rat trap in January and two were recaptured in the tunnels in May. None of the three individuals released in October was recaptured, but the one individual released in November was recaptured in the same tunnel in December. Of the one *Desmodus rotundus* and the ten *Anoura geoffroyi* released in September, none was recaptured.

SUMMARY

The home range of tropical marsupials and mice has been studied by recapturing marked mammals. The individuals were trapped, marked and released along a trail in a second-growth forest near Teresópolis, State of Rio de Janeiro, Brazil, from August 1942 to September 1943. In addition, some bats were released and recaptured.

Females of the common opossum, *Didelphis marsupialis*, tended to remain within a small area for many months, although the males were seldom recaptured. Individuals of the woolly opossum (*Caluromys philander*) returned to the same trees for many months.

Mice belonging to three species (*Thomasomys sublineatus*, *Akodon arviculoides* and *A. nigrita*) were consistently retrapped within 100 meters of the location of original capture. Of 155 mice released, 82 were recaptured and 53 were recaptured in more than one month. The mice were recaptured a total of 152 times, and in only 15 instances was the site of recapture more than 100 meters along the trail from the place of original capture. These mice appear to have a home range with a radius of less than 100 meters.

Bats, representing three species (*Carollia perspicillata*, *Desmodus rotundus* and *Anoura geoffroyi*), were captured in artificial tunnels. The number of individuals decreased sharply from October to December, but during the rest of the year, in spite of the fact that all bats captured were killed, many individuals were captured in the tunnels, indicating that bats were moving into the tunnels during this period. Of the 9 bats (*Carollia*) banded and released in September, one was recaptured in January and two were recaptured in May. None of the 11 bats (*Anoura* and *Desmodus*) released in September was recaptured.

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COLOR CHANGES IN MAMMAL SKINS DURING PREPARATION

By Stuart C. Downing

Originally this paper was to have been published under the joint authorship of E. C. Cross, L. A. Prince and the present writer, of the Division of Mammals, Royal Ontario Museum of Zoology. The outbreak of the war terminated the experiments being conducted by the Mammal Division and the whole matter was left in abeyance in the hope that it could soon be resumed and more definite conclusions reached as to the effects of preparation on the colors of mammal skins. However, it is now apparent that this work will not be resumed for some time and as the implications involved are far reaching in their bearing on taxonomic studies, it has been deemed advisable to place the experiments on record incomplete as they are.

Museum workers have long known that the natural colors of mammal skins are altered by long immersion in solutions of alcohol, formalin, salt, alum or similar preservatives. "Fading" due to long-continued exposure is equally well known and examples may be seen in the exhibition halls of any museum. Color changes such as these have clearly been caused by harsh treatment of the specimens, but it appears to have been tacitly accepted that the natural colors of animals are not altered by normal museum methods of preparation. However, it has been forced on the attention of the staff of the Royal Ontario Museum of Zoology that the colors of at least some groups of animals may be seriously altered even by normal practice.

A series of 28 red squirrels (*Tamiasciurus h. hudsonicus*) collected by L. A. Prince at Favourable Lake in 1937 was noted as showing marked dichromatism when being incorporated into the collection. Twenty-five specimens had uniformly tawny olive sides and backs, while three were much darker in tone and had reddish sides and backs. On inquiry it was discovered that the 25 tawny olive skins had been made up in the field but the 3 reddish skins had been merely skinned out, dried and later relaxed and made up in the museum laboratory.

A rapid survey of the museum's red squirrel collection revealed a considerable number of skins with the same dark tone and reddish coloration noted in the three Favourable Lake specimens. These skins without exception proved to have been relaxed and made up in the museum laboratory. This was rather alarming in view of the importance of coloration in taxonomic work and an investigation was begun to ascertain where in the preparation process the color changes had occurred.

In recent years borax has been the preservative used by our field parties. Prior to that, arsenic or an arsenic and alum mixture was used and a few specimens in the collection were preserved with salt alone. The practice in making up dried skins has not varied in recent years and is as follows:

(1) The dry skin is relaxed by soaking in lukewarm tap water, usually over night.

(2) The relaxed skin is washed briefly with soap and water.

(3) The skin is then rinsed in a degreasing agent such as varsol or carbon-tetrachloride and, if greasy, allowed to stand in it for half an hour or so.
(4) The skin is dried in sawdust, using compressed air to assist the drying and to blow the sawdust out of the hair.

As a first test of the effect of this procedure four pieces of skin from a freshly-killed squirrel were thoroughly saturated with one of the four dry preservatives (arsenic, alum, borax, salt), placed in an electric oven and held at 60° Centigrade for 24 hours. Not one of the four pieces of skin so treated showed any change in color.

Four other pieces of skin were taken from the same red squirrel pelt, saturated with the four preservatives as above and then soaked in lukewarm tap water over night. The hair of each of these pieces of skin after such treatment showed a pinkish coloration not present in the control pieces. As a fresh pelt had been used in this test, pieces of dried skin were immersed over night as a check. The effect on the dry skin was the same as that on the fresh.

A more elaborate series of tests was then undertaken, using distilled water alone as well as supersaturated solutions in distilled water of borax, of salt, of arsenic and of alum. Thirty sections were cut from two freshly-killed red squirrels. A corresponding piece as a control was also cut from each section. These sections were numbered, their position in the pelt recorded and the color of each section determined from Ridgway's color chart. These sections were then immersed in the solutions for periods varying from 1 to 64 hours.

A detailed study was made of each sample after it had been removed from the solution and dried. The results may be summed up by saying that after soaking for even one hour, the hair of the samples had without exception altered appreciably in color. The original samples were *Tawny* but after soaking for one hour, the borax treated and salt treated samples were *Hazel*, the arsenic treated sample was between *Tawny* and *Russet*, the alum treated sample was between *Russet* and *Hazel* and even the distilled water treated ample showed a perceptible change from the *Tawny* check.

The samples that had been soaked for the longer periods showed further darkening and deepening of color. Arsenic treated and distilled water treated samples showed the least change, borax treated the most change; alum treated and salt treated samples were intermediate. Although the above preservatives increased the amount of change which took place, even soaking the skin in distilled water caused a marked alteration of the normal hair color.

These tests clearly showed that the soaking of the skin was the stage of the preparation process in which color change occurred. A variety of supplementary tests confirmed this conclusion.

The outbreak of the war prevented similar tests from being conducted on other groups of mammals but a careful examination was made of such specimens in the museum collection as were known to have been made up from previously dried skins. These specimens were compared with material that had been made up directly from fresh specimens. It was found that changes in color had taken place in many species, as listed below. In general the change was similar to

that which had occurred in the red squirrel. The yellow and buffy colors had become much deeper in tone and exhibited a cinnamon, pink or reddish cast.

As a supplement to this investigation a cursory examination of the bird collection was made by T. M. Shortt and C. E. Hope of the Division of Birds to determine if evidence of similar changes in reddish or brown species of birds could be found. The results of this examination are appended below to the list of changes found in the mammal collection. The color terms used are those of Ridgway.

COLOR CHANGES IN MAMMALS

LEPORIDAE

1. *Lepus americanus*
   - A. Change quite marked over entire animal, being most marked on head and face.
   - B. *Clay Color* changed to *Cinnamon*.
   - C. Little change in tone value.

SCIURIDAE

1. *Marmota monax*
   - A. Well marked change on dorsal surface.
   - B. No evident change in red of underparts.
   - C. Change involves light upper band of underfur.
   - D. These light bands have changed from a *Pinkish Buff* base and a *Snuff Brown* tip to a *Pinkish Cinnamon* base and a *Cinnamon-Brown* tip.
2. *Eutamias minimus*
   - A. Change extremely well marked over entire animal, reaching climax along the sides.
   - B. Color changed from *Clay Color* and *Yellow Ocher* to *Orange-Cinnamon*.
3. *Glaucomys sabrinus*
   - A. Change not particularly noticeable, only the underparts being definitely changed.
   - B. Upper parts seemed to be a little redder, but not definitely so.
   - C. *Marguerite Yellow* tints on underparts changed to *Pale Pinkish Buff*.
4. *Sciurus carolinensis*
   - A. Very well marked change throughout the animal wherever *Clay Color* occurs.
   - B. Greatest contrast is shown along the sides.
   - C. *Clay Color* changed to *Cinnamon-Rufous*.
5. *Sciurus niger*
   - A. Probably the most marked change in any of the species examined.
   - B. Change includes every part of the body.
   - C. From above, the animal appeared much darker, the buffy portions of the hair became much deeper in tone, tending toward cinnamon.
   - D. The under surface including the tail changed drastically, the body from *Pinkish Buff* to *Vinaceous-Cinnamon*; the tail from *Yellow Ocher* to *Ochraceous-Orange*.
6. *Tamias striatus*
   - A. Change not so obvious as in most of the other Sciuridae examined.
   - B. *Cinnamon-Buff* changed to *Pinkish Cinnamon*.
   - C. In unsoaked condition this species has more cinnamon to start with than any of the other Sciuridae examined, which may explain the less amount of change.
7. Deep cinnamon tints in some of our ground squirrels, which we know were relaxed and made over, suggest a change has taken place, but we have no comparable material of known treatment to make a definite statement.

CRICETIDAE

1. *Microtus pennsylvanicus* and *Clethrionomys gapperi*
   A. Specimens taken in water traps as compared with ones taken in mouse traps, no change could be ascertained.
   B. Soaked as compared with unsoaked specimens—this is indefinite. There is a suggestion of reddening in some cases. Before this could be attributed to soaking, experiments would be necessary.
2. *Peromyscus*
   A. Slight suggestion of reddening, but not sufficient change to warrant any conclusions without carrying out experiments.

ZAPODIDAE

1. *Zapus hudsonius*
   A. In some specimens taken in water traps the *Ochraceous-Buff*, which lightly suffuses the underparts, has been greatly deepened in tone and occurs as streaks and blotches on the usually white ventral surface.
2. *Napaeozapus insignis*
   A. Specimens from water traps are definitely redder than ones from the same area taken in mouse traps.
   B. Soaked specimens are markedly redder.

INSECTIVORA

1. No material known to have been made over from dry skins.
2. No visible change in *Sorex cinereus* and *Sorex palustris* taken in water traps as compared with specimens taken in mouse traps.

CHIROPTERA

1. No visible change in three specimens of *Myotis lucifugus* known to have been relaxed and made over.
2. A relaxed and made over Hoary Bat (*Lasiurus cinereus*) is redder than the few others we have, but not enough to be conclusive.

COLOR CHANGES IN BIRDS

1. Marsh Hawk (*Circus hudsonius*). Juvenile plumage.
   A. Underparts changed from *Cinnamon* to between *Hazel* and *Russet*.
2. Short-eared Owl (*Asio f. flammeus*). Downy young and juveniles.
   A. All *Cinnamon-Buff* areas changed to *Cinnamon*.
3. Eastern Hermit Thrush (*Hylocichla guttata faxoni*). Adults.
   A. Colors of the back changed from *Sepia* to *Prout's Brown*.
4. Olive-backed Thrush (*Hylocichla ustulata swainsoni*). Immatures.
   A. The back changed from *Brownish Olive* to between *Sepia* and *Bister*.
   B. The *Cream Buff* of throat and chest changed to *Pinkish Cinnamon*.
5. Sharp-tailed Sparrow (*Ammospiza caudacuta*). Juveniles.
   A. The *Clay Color* areas changed to *Tawny*.

DISCUSSION AND CONCLUSIONS

(1) It is evident that skins of many species of mammals that have been relaxed and made up from dried skins have suffered changes in color which render them almost useless for taxonomic studies in which color is an essential character.

(2) A consideration of the results of the tests made on the red squirrel indi-

cates that the present museum practice of making over skins in the laboratory by soaking specimens collected and dried in the field must be greatly modified and perhaps abandoned for some species. All such material so treated in the past must be placed under suspicion. Some of it, as far as color is concerned, will be found to be useless for taxonomic studies.

The Sciuridae appear to be more seriously affected by current methods of making up museum study skins from material skinned out and dried in the field than are other groups. Even in those groups not so drastically affected, the importance of detecting even slight color changes should be recognized especially in studies involving subspecific distinctions.

(3) The problem of cleaning dirty or greasy skins and of relaxing dried skins is one that must be considered anew by museum preparators. The extent of the change in color appears to depend on the length of time the hair is in a moist condition. Our tests show that a slight but perceptible change had taken place in the hair color of a red squirrel after one hour of soaking. The problem then is one of how long a skin can be soaked without changing its color. Some members of our staff believed they could detect a subtle change after half an hour of soaking while others thought no change had taken place. Skins that have changed only slightly may be those most likely to lead the taxonomist astray, because he may fail to realize that the skins are not of normal coloration.

It may be possible by rapid relaxing, washing and drying to avoid producing any color change. This, however, will require further investigation. In the meantime any specimen that is relaxed and made over or washed in the process of preparation should bear this information on the label.

(4) The water trap is of questionable value as a means of securing specimens. Perhaps the majority of the specimens so taken do not suffer a change in color, but many jumping mice certainly do so. Any specimen captured in a water trap should have this information stated on the label.

(5) To what extent conclusions as to subspecies and other taxonomic groups have been vitiated by changes in coat colors produced by methods of preparation is a matter that must receive attention.

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MRS. WALLIHAN: A PIONEER PHOTOGRAPHER OF WILDLIFE

By Viola S. Schantz

Mrs. A. G. Wallihan had a heart alive to all the beauties of nature, which she and her husband enthusiastically portrayed in their photographs of wildlife in a publication entitled "Hoofs, Claws, and Antlers of the Rocky Mountains". This book was published in 1894 by Frank S. Thayer, at Denver, Colorado.

She was born of Revolutionary stock in Milwaukee County, Wisconsin. Perhaps for obvious feminine reasons her birth date is omitted.

"Her father was a fine shot and could drop a partridge, ruffed grouse, or squirrel from the top of a tall maple tree, taking the head off at every shot with the muzzle-loading rifle he used." He would also shoot black bear, cougar, and wild cat. He would follow deer for miles, but she didn't remember his ever shooting one. As a girl she often sat by her father's side watching him mold the round bullets and thinking them so beautiful and shiny. While interested in shooting she did not have an opportunity to try her skill until after she was married. They were miles from any house, alone in the mountains, at Lily Park, Colorado. Her brother and Mr. Wallihan wanted her to learn to shoot.

Mrs. Wallihan became quite skillful with a rifle. Some friends on the White River sent a message to Mr. and Mrs. Wallihan now residing at Lay, Colorado, to "come and get some mountain lion pictures". They took their pack of dogs, camera, and rifles across Piceance Creek just above White River City and up on the north slope of the mountain facing White River. There they found the lion in a cedar which grew on top of a small cliff. During these tense moments she approached with utmost composure within 30 feet of the treed lion to photograph it. She set up the camera and when ready shouted at the lion which looked at her. She waved her one hand while with the other she pressed the bulb that opened the shutter. Wishing to get closer she went down around a tree on the left within 25 feet of the animal when two rifles cracked simultaneously and stopped his colt-killing career.

In the fall of 1891 her husband, who was postmaster at Lay, Colorado, told her to get the winter's meat supply while he took photographs of deer. They started out on their ponies with rifle and camera. The first day she got nothing. The second day she came across a group of two fine bucks and a number of does and fawns. "Quicker than I can tell it I fired and killed the two bucks at 130 yards with one shot", thus proving her luck and marksmanship.

She and her husband relate some of their early photography experiences with the elements in early fall at Bear River in Juniper Canyon, where they had gone to photograph deer as they crossed the river. They arrived in camp at noon, took care of their team, and were off. Packing along their cameras they walked about a mile beside the river's edge, over rocks and sand, with the sides of the canyon towering nearly perpendicular above them. Finally they reached a suitable place to set up the cameras. They waited a long time but no deer came. The wind blew up very cold and they were forced to return to camp. Before they could pitch the tent it was snowing and a high wind blowing. They

gathered sage brush for firewood and put it in their tent to keep it dry. Mr. Wallihan hurriedly cooked the supper out in the storm, and they drank their hot tea with venison, bread and butter, then crawled into their blankets. Mrs. Wallihan said "I think I never was so cold in my life. While I lay there shaking

PLATE 1

Mrs. A. G. Wallihan, one of America's first feminine wildlife photographers.

I could hear the patter of the snow on the tent and the wind kept up its howl. I shook the harder for hearing it. Sleep came at last." The next morning after sunrise they were off for the trails and that day took two photographs, one of a doe and fawn coming down the river. "After quite a bit of looking and starting they finally struck out and swam nearly straight across. They landed,

shook themselves for a minute, and climbed up the mountain." Another of a band of mule deer—"It was quite amusing to watch a bunch of deer take the water when the river is high. Some will wade deliberately in and start swimming easily, others will plunge in, and some leap as high and far out as possible, go clear under, bob up serenely, shake their heads, and swim furiously for the other shore."

Most of the photographs were taken in the northwest portion of the state of Colorado, on what is known as the western slope of the Continental Divide, the Wallihans' most nearly central point of rendezvous being Glenwood Springs.

Their book contains 36 plates consisting of various groups and individuals of deer, antelope, elk (one plate shows a band of 200 animals, and another 250), cougar, mountain sheep, wild cat, American buffalo, black bear, beaver, wolf, jack rabbit, and prairie dog.

In order to make the collection of wild animals found in the Rocky Mountains more complete the publishers used several photographs obtained by other persons.

The introduction of "Hoofs, Claws, and Antlers of the Rocky Mountains" is written by Theodore Roosevelt, with the following excerpts:

"It has never been my good fortune to see as interesting a collection of game pictures as those that have been taken by Mr. and Mrs. Wallihan.... The book, when published, will be absolutely unique and of utmost value. The picture of the bunch of deer watering at the spring pool in snowy weather gives an idea such as no written description could of the way deer look as they come down to drink in a band. Then pictures of the two startled bucks just about to jump off, and the buck and the doe, the doe still unconscious and the buck looking suspiciously in the direction in which the camera is, are just as good in their way. So with the antelope pictures. The alertness of the antelope, the queer prong-horned beasts, is caught to perfection, as well as the difference in their attitudes when compared with the attitudes of the deer. Knowing as I do by long experience the extreme difficulty of getting so much as a shot with the rifle at either wolf or cougar, I cannot express my astonishment at seeing these remarkable and characteristic photographs of both. The cougar in the tree has a special and peculiar value, showing as it does the way the beast stands. The wolf slouching over the hill is so characteristic that I seem to see him in the flesh as I look at the picture.... So it is with all these pictures,... the vividness, simplicity, and truthfulness with which Mr. and Mrs. Wallihan have told their stories add greatly to their value. It is a credit to Colorado and the United States that a book of this kind should be produced." (Signed—Theodore Roosevelt). This introduction is indeed a high compliment paid by such an outstanding wildlife enthusiast as Theodore Roosevelt.

Comparison today, nearly a half century later, of the results attained by the Wallihans with their cumbersome wildlife camera technique, up-to-date at the time, show them to be hardly excelled, if at all, by our present experts in the field. Truly, Mrs. Wallihan justifies the sobriquet "One of America's first feminine mammalian photographers".

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NOTES ON THE LIFE-HISTORY OF THE LITTLE SHORT-TAILED SHREW

By William B. Davis and Leonard Joeris

The following notes on the little short-tailed shrew (*Cryptotis parva*) are presented to supplement those published by Hamilton (Jour. Mamm., vol. 25, no. 1, pp. 1–7, 1944) and Moore (Proc. Florida Acad. Sci., vol. 6, pp. 155–166, 1943). They are derived from field and laboratory observations made in the vicinity of College Station, Brazos County, Texas, by Joeris during the fall and winter of 1941, along with observations by Davis during the period 1937–1944.

Habitat.—In the vicinity of College Station, short-tailed shrews occur most commonly in pastures, vacant lots, and fields where the dominant vegetation is grasses (*Andropogon*, *Cynodon dactylon*, and *Sorghum halepense*) intermingled with weeds and forming a dense canopy under which the shrews can move about in runways of their own or those of cotton rats (*Sigmodon hispidus*). Most of the 40 or more specimens we have examined from this vicinity have been trapped in runways of *Sigmodon*. One individual was captured in a timbered area; in this instance the shrew had taken up quarters under a rotting log. The type of soil seems to be of minor importance in determining their distribution; shrews have been taken on both sandy and clayey soils, but nearly always in dense stands of grass.

Burrows.—Three burrows occupied by short-tailed shrews were found and examined. One appeared to be nothing more than a partly enlarged crack in heavy clay soil. It extended below the ground about 8 inches and terminated in a nest. The second appeared to have been excavated by the shrew itself. It was in sandy loam soil, slightly less than 1 inch in diameter, 10 inches long, and 8 inches below the surface at its deepest part. It also terminated in a nest chamber. The third, excavated on December 6, was in clay loam soil in a Bermuda grass pasture. It was at least 5 feet long, 8 inches below the surface at the deepest point excavated, and had a short side branch that led to a rather large nest chamber.

Captive shrews were observed excavating burrows in soft soil in a glass vivarium. In this instance two shrews cooperated, one doing most of the digging, the other pushing the loosened earth out of the burrow and packing the walls of the tunnel. The front feet were utilized to loosen the soil, which was then thrust backward under the belly of the animal and kicked further to the rear by the hind feet. There the second shrew took it and pushed it ahead of him by using the front feet and chest to hold the earth and the back feet for propulsion. Most of the loosened earth was packed into the sides of the tunnel; a small quantity was scattered near the entrances. The two, working almost continuously for two hours, completed a burrow two feet long and with four openings.

In loose, damp soil, captive shrews were observed to force themselves, mole-like, through the top layer, pushing up a tiny ridge as they progressed. Perhaps

this is a common practice in leaf mold, soft humus, and other loose soils, and is associated with food getting.

Nests.—The three natural nests examined were rather compact structures composed of dried, shredded grass blades, roughly globular in shape and with an entrance on the side. One used as a nursery was about the size of a man's fist; another, which was being used as winter quarters by 12 shrews, was about twice as large.

Sociability.—As Hamilton (*op. cit.*) points out, these shrews are sociable. We have kept as many as four at one time in a cage and they never fought except when a single morsel of food was offered to them. They slept together in the same nest and ate together when food was plentiful. On several occasions when two occupied the cage, the smaller one was observed to carry food into the nest for the larger one. When food was scarce, however, this form of cooperation was not observed. That sociability is not forced upon them by being caged is evidenced by the catching of 2 individuals at one time in a live trap and by the finding of a winter nest on December 6 that was being used by 12 individuals.

Cleanliness.—Captive shrews were meticulous in their personal cleanliness, "washing" and combing their fur with the fore feet. After scratching the body with the hind feet, the feet were also cleaned. Special places in the cage were sometimes used for defecation. The nest was always clean.

Activity.—Our experience with captive shrews is that they may be active at all hours of the day, but the peak of activity is at night. That this is also true under natural conditions is borne out by trapping records. Most of the daylight hours of caged animals were spent in the nest, sleeping or resting. At such times the animals usually lay curled up on their side; occasionally they were observed to sit hunched up on all four feet.

We observed that shrews rarely entered our live traps as long as the weather was mild and natural food was present in quantity in the area, but after the first cold spell of the fall, which came in early November in 1941, seldom did we fail to catch at least one shrew each time our traps were set. On December 12 three shrews were captured individually in one trap in a period of 24 hours. One interpretation of these data is that the shrews were more easily attracted to the traps after the insects and other small invertebrates were reduced by cold weather. Because of the finding of 12 shrews in one nest on December 6, however, it may be that the shrews had concentrated in our trapping area after cold weather began and were more frequently caught simply because they were more abundant. We do know that cotton rats in this vicinity concentrate in favorable areas of lodged grass in winter and disperse widely in spring and summer. It seems likely that *Cryptotis* behaves in a similar manner.

Food.—Captive shrews were fond of sow bugs, grasshoppers, and crickets, but hard-shelled beetles were avoided if other foods were present. If a choice of foods were offered, crickets were preferred over grasshoppers and the latter over sow bugs. The shrews also ate hamburger and skinned carcasses of mice, but they appeared to be afraid of a live house mouse (*Mus musculus*) that was placed in the cage with them. They left it strictly alone after sniffing it a few times.

However, they were cannibalistic to a certain extent. A shrew that died in captivity was attacked by those that remained. On two occasions when two shrews were caught together in a live trap, one had been partly eaten by the other.

When a surplus of insects and sow bugs were placed in the cage, each one was immediately seized and killed. Those not consumed were cached in one corner of the cage. One of the shrews placed 12 black crickets in a corner of the cage in less than 5 minutes. These insects were consumed later. Perhaps this demonstrates a natural tendency for *Cryptotis* to store food, but, so far, no field observations substantiate this supposition.

As Hamilton (*op. cit.*) points out, digestion is rapid. After changing the diet of our shrews from insects to hamburger, the fecal pellets changed in consistency within 2 hours. This rapid metabolic rate requires a large intake of food. In a period of 12 hours, one of our captive shrews ate 3 crickets, 25–30 sow bugs, 1 beetle about three-fourths of an inch long, and it was still hungry.

Reproduction.—We have little data on the breeding habits of *Cryptotis* in Texas. None of our winter-taken (November to February) specimens showed evidence of breeding activity. Three young ones devoid of hair and with eyes and ears unopened were found in an underground nest on September 26. These measured 22 mm in total length and weighed 0.3 gram each. A female containing four fetuses 10 mm in rump-crown length was captured on October 20 and another containing three embryos on October 24.

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THE WINTER HABITS OF THE NORTHERN WHITE-FOOTED MOUSE

By Hans Peter Thomsen

The white-footed mouse (*Peromyscus leucopus noveboracensis* Fischer) has been studied extensively by Wood (1910), Dice (1922) and others. Svihla in 1932 studied the breeding habits of this mouse. Murie and Murie (1931), Burt (1940), Blair (1942) and Nicholson (1941) studied home range, territoriality and the social life. Most of the field studies with the exception of Nicholson's were done during the warmer months of the year. This, I assume, is mainly due to the natural difficulties of winter trapping and to the fact that trapped animals easily succumb to the cold if left unattended all night.

This study was conducted around a lodge situated in an oak-hickory forest on the shores of Lake Mendota, Wisconsin, where I lived during the winter of 1943–44. The forest consists mainly of red oak (*Quercus rubra*), white oak (*Quercus alba*) and black oak (*Quercus velutina*); some hickory (*Hicoria ovata*) and basswood (*Tilia americana*). These trees are all at least 50 feet or higher. Near the lake shore a few red dogwood (*Cornus* sp.) and hazel (*Corylus* sp.) shrubs grow.

Natural forest reproduction here is checked by the land owner who each fall removes part of the understory and places the cut branches in erosion gullies near the lake shore. Natural reproduction is also more or less controlled by a fairly high rabbit population that utilizes the brush piles as shelter.

Early in November I noted several small holes of about 1½ inch in diameter below my bird-feeding station. They seemed to lead below the lodge. Trapping indicated that these holes were made by white-footed mice. Twelve traps of the treadle type and an additional eight of the tin can type were obtained. All were numbered and rotated at each setting to avoid misses of a possibly badly functioning trap. The traps were set two or three times weekly from December 4 to February 27 and inspected once or twice each night depending on the time of the setting. Five more sets were made on March 1, 5, 6, 12, and 14. Peanut butter was used as bait in all traps. Wads of cotton were placed in each trap to keep the captured animals warm. Each mouse caught was marked in the ear with a punch and fine scissors and released at the place of capture.

MOVEMENT

The white-footed mouse enters the trap readily. The same mouse has been caught twice in the same night. During the first 10 days, December 4 to 14, only the region around the lodge was trapped. Mice were recaptured after the second night. No new mice were caught near the lodge after the fifth night of trapping. Consistent trapping through January 4 produced only marked mice.

It was evident that the mice lived underneath the building. After December 20 I placed traps over a greater radius around the lodge. More traps were used, but mice were caught only in the immediate vicinity, usually within a radius of about 25 feet. All these captured mice were from the original marked population of six. On January 1, the traps were scattered in a loose pattern around the lodge about 50 to 70 feet from the building. Not a single mouse was caught. On January 4, 20 traps were placed at distances ranging from 25 to 150 feet from the building. The traps nearest the lodge held two marked mice from the area. The other traps were empty. On January 6 the traps were again set in a 50 foot radius around the lodge, but four hours of trapping brought no results.

I now decided to investigate how close the nearest other mouse colonies were. On January 7 I placed my traps near what I thought would be a suitable winter shelter or habitat for mice. Ten traps were placed near the lake shore among the brush piles, which are about 200 feet away from the building. Another 10 traps were set by a mound of large stones situated across the road and approximately 150 feet from the building. Two mice were caught among the stones and not less than six among the brush piles in the erosion gullies near the lake shore. This set was repeated on January 9 and four of the mice caught on the 7th were recaptured.

Further trapping from January 13 to February 27 showed that each of the three brush piles near the lake shore was inhabited by a group of mice. The

populations were 3, 5, and 4 respectively. The stone mound had a population of 4. Females predominated in all but one group, as indicated below.

STATION	MALE	FEMALE
Lodge	2	4
Brush pile no. 1	1	2
" no. 2	2	3
" no. 3	1	3
Stone mound	2	2

According to the trapping results, it would appear that each group frequents only the immediate vicinity of its respective shelter. As with the lodge, the mice did not venture farther than 25 to 30 feet from the shelter and mice marked near one shelter place were never caught near another.

DOMINANCE

On January 23 all the mice from the lodge area were removed. Three of these, a male and two females, were placed in a cage. During the day the mice remained quiet, huddled in a corner of the cage. This "huddle" was always of a definite pattern that never changed throughout the entire period of captivity. One female mouse was always on the bottom, the second female next and the male was always on the top. Perhaps this was an expression of social dominance although I can not be sure which animal should be considered dominant since no fighting was observed. It is assumed that the mice spend the day in their winter nest in a similar pattern. A small animal like the mouse needs other mice in order to conserve body heat. Allee (1938) reports Veteloni found that mice raised solitarily grew more slowly than those raised in groups.

TERRITORIALITY

Several factors may affect the range of the mouse in winter. Hatfield (1940), who studied this species in the laboratory, showed that cold caused a decrease in activity and food consumption. The brush piles may also have acted as artificial shelter places into which the mice were drawn. It should be pointed out that the winter was fairly mild. I believe that it was not the reduction of shelter or, for that matter, the creation of artificial shelter that made the mice behave as uniformly as they did. One of the main factors in this behavior pattern may be based on territoriality.

I placed several mice from one group into a cage where three mice from another group were present. The mice were introduced one at a time and each was immediately attacked by the caged mice. Stoddard (1931) noted that bob-whites attacked strangers introduced into the winter pens and that this attack "may lie in an instinctive desire to prevent additional birds from sharing an already overcrowded range." Errington and Hamerstrom (1936), writing about the bob-white, state that "the fall strife between whole coveys is probably a manifestation of intolerance. This is distinct from the breeding season com-

bats." Nice (1941) writes in regard to winter territory, "An area used as a feeding ground and defended against other birds of the species resembles typical territory, but differs . . . by the absence of sexual selection." Doubtless areas that are defended by more than one member of a group and where sexual behavior is wanting exist also among mammals. Carpenter, for example, describes territorialism of groups of apes and monkeys.

Burt (1940) found that female *Peromyscus* have separate areas that can rightly be called territory during the breeding season. In a later paper, Burt (1943) emphasizes the fact that home range and territoriality are not synonymous. Recognition is doubtless present among the individuals of a winter unit of mice since those from the same area did not fight when placed in the cage together, while a mouse from another unit was immediately attacked.

As formerly mentioned, the entire mouse unit was removed from the lodge area on January 23. This vacant area was checked periodically to see whether new mice moved in. Ingress did not occur until March 5, 42 days after the removal of the resident mouse group, when two mice were caught. Both of these were males that had not been marked for identification. It must be assumed that they came from areas other than those previously trapped. On March 12 and 14 one of these mice was recaptured in the lodge area. Unfortunately the study was discontinued then and no more data on ingress could be obtained. It is difficult to say whether ingress resulted from the lack of social pressure formerly exerted by the resident mice or from the general activities of spring pairing.

More winter studies should be conducted to verify this group territory concept in the white-footed mouse.

Grateful acknowledgment is here made to Professor Aldo Leopold, University of Wisconsin, and Dr. Wm. H. Burt, University of Michigan, for the critical reading of the manuscript.

SUMMARY

1. In the area studied, white-footed mice lived in groups of 6, 5, 4, 4 and 3, during the winter months of 1943–44. Females predominated in all but one group.

2. Individuals of these groups did not range farther than 30 feet from their places of shelter, and were never caught near the shelter of another group.

3. Caged mice of one group did not tolerate mice from another group.

4. The captive mice huddled together in a definite pattern. This pattern is probably based on social dominance.

5. Ingress of two males occurred 42 days after the removal of a mouse unit.

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SOME MAMMALS OF OZARK COUNTY, MISSOURI

By A. Starker Leopold and E. Raymond Hall

In the course of an investigation of wild turkeys in south-central Missouri from December, 1939, to August, 1943, the following information about mammals was obtained by Leopold. Headquarters were maintained during this period at a point five miles north of Gainesville, Ozark County, on the Caney Mountain State Game Refuge—an area of 5,500 acres, and unless otherwise indicated, specimens mentioned were taken within a radius of one-half mile of the Headquarters. Hall identified all specimens and contributed the parts of this report which concern taxonomic problems. No records were obtained of some species that almost certainly are present, as for example several bats, a shrew or two, and the deer-mouse. Subspecific names are provided only for the kinds of mammals of which specimens were saved. Most of the specimens are in the University of California Museum of Vertebrate Zoology.

Information about furbearers and some of the larger game species was obtained in part from local hunters and trappers. The late Joe Morrison, first superintendent of Caney Mountain Refuge, was a particularly rich source of historical information.

ACCOUNTS OF SPECIES

Didelphis virginiana. Opossum.—Abundant and heavily hunted throughout Ozark County; frequently observed at the Refuge Headquarters.

Scalopus aquaticus machrinoides Jackson. Mole.—Workings occur more often in alluvial soils than elsewhere, although some were found on a ridge-top in an abandoned field. The one specimen saved is a male taken February 23, 1943. Its color agrees with the description of *machrinoides* given by Jackson in his monograph (N. Amer. Fauna, no. 38, p. 45, 1915). Selected measurements are: total length, 164; length of tail, 24; length of hind foot, 21; interorbital breadth, 7.7; maxillary tooth row, 11.6; mandibular molar-premolar row, 11.4. These measurements are relatively small and indicate that the specimen, like others recorded by Jackson from Carthage, Missouri, and Winslow, Arkansas, is an intergrade between *machrinoides* and the smaller *pulcher* to the south.

Procyon lotor. Raccoon.—Not abundant in the County, apparently because of heavy hunting. On Caney Mountain Refuge raccoons have increased in number since the elimination of hunting in 1940.

Mustela frenata. Weasel.—Uncommon according to local trappers.

Mustela vison. Mink.—Rare in Ozark County and over most of the Missouri Ozarks. One was examined which had been trapped in December, 1942, five miles south of West Plains, Howell County.

Spilogale interrupta (Rafinesque). Spotted-skunk.—Rare in Ozark County and increasingly rare to the eastward. One specimen was obtained from Blanche, Douglas County, and two from five miles south of West Plains, Howell County.

Mephitis mephitis. Striped skunk.—Individuals frequently were observed around old fields on Caney Mountain Refuge and on Blue Spring Refuge, four miles east of Dora, Ozark County. Judging by the fur take, *Mephitis* is at least 10 times as abundant in the County as *Spilogale*.

Canis niger rufus Audubon and Bachman. Red Wolf.—Two adult males were saved as specimens. They are, Univ. Calif. Mus. Vert. Zool. catalogue no. 98038, November 3, 1941, from five miles north of Gainesville; and no. 98039, March 16, 1942, from three miles north of Thomasville, Oregon County. Selected measurements are, respectively: total length, 1288, 1397; tail, 337, 381; hind foot, —, 216; ear from notch, 108, 127; condylobasal length, 197, 197; zygomatic breadth, 107.8, 110; weight of entire animal, 35, 46 lbs. The animals are referred to the subspecies *rufus* rather than *gregoryi* because of their small size. In addition to specimen no. 98038, two other wild *Canis* were taken on Caney Mountain Refuge. One of these was a nonpregnant female trapped April 17, 1943. With stomach contents she weighed 34½ lbs. The stomach contained all of a new-born goat, even to the hooves and head. The third animal was a male, judged to be young. It was taken April 28, 1943, and weighed 30 pounds.

Vulpes fulva. Red fox.—Fairly abundant and apparently increasing in proportion to gray foxes. Of 12 foxes trapped on Caney Mountain Refuge from 1940 to 1943, 4 were of this species and 8 were *Urocyon*.

Urocyon cinereoargenteus ocythous Bangs. Gray fox.—Three specimens were saved, all trapped five miles north of Gainesville. One was a female (Univ. Calif. Mus. Vert. Zool. catalogue no. 98037), taken on January 22, 1942. The other two were adult males, taken two days before, both of which are in the collection of the Missouri Cooperative Wildlife Research Unit. One of these is entirely lacking guard hairs, and therefore is a "Sampson fox" of fur-trade terminology.

Felis concolor. Cougar.—The last cougar remembered by old residents of the Caney Mountain region was killed about 1885, four miles northwest of Gainesville, by Chris Morrison.

Lynx rufus. Bobcat.—Bennitt and Nagel (A survey of the resident game and furbearers of Missouri. Univ. Mo. Studies, 12, no. 2: p. 178, 1937) report that from 1925 to 1934, 100 bobcat scalps were presented for bounty in Ozark County. At present, however, the species is rare there. It is still locally abundant in parts of the eastern Ozarks; four to five are trapped each year on Wilderness Refuge in northeastern Oregon County, but west of there the bobcat appears to be decreasing in numbers. No positive evidence of the existence of bobcats on Caney Mountain Refuge was obtained. One was seen in 1942,

five miles south of Willow Springs, Howell County, by T. M. Roberts, patrolman of the Carman Spring Refuge. This point is 10 miles northeast of the corner of Ozark County.

Marmota monax. Woodchuck.—Abundant in the County, not only on farmlands but in the woods, as at the Refuge Headquarters.

Tamias striatus venustus Bangs. Striated chipmunk.—In Missouri this species is common in the eastern Ozarks but progressively less common to the westward; only two individuals were seen in Ozark County. One was 5 miles north of Gainesville and the other 4 miles northeast of Rockbridge. The one specimen saved is from 20 miles southeast of Alton, Oregon County.

Sciurus carolinensis. Gray squirrel.—Abundant throughout the County. There appear, however, to be marked fluctuations in the numbers of both gray and fox squirrels from year to year. In 1940, both species (but particularly *niger*) were so numerous on Caney Mountain Refuge as to make cultivation of food patches for wild turkeys unprofitable; small fields of corn, adjoining woodlands, were stripped of ears by December. In 1941 and 1942, on the contrary, both species were surprisingly scarce and caused no damage to crops. Bennitt and Nagel (*op. cit.*) cite evidence indicating that gray and fox squirrels are irregularly migratory, and that populations also may be affected adversely by drouth. There was no evidence of migration of squirrels during the present period of observation, and conditions of rainfall and food supply (principally acorns) were favorable. The decrease in 1941 seemed to be a local phenomenon, for which we have no explanation. Both species were increasing in 1943.

Sciurus niger. Fox squirrel.—In upland timber, such as on Caney Mountain Refuge, fox squirrels outnumber grays; the reverse generally is true along streams and river bottoms.

Glaucomys volans. Flying squirrel.—Five miles north of Gainesville, one adult was observed and a nest of young was found.

Castor canadensis. Beaver.—Bennitt and Nagel (*op. cit.*) report that beavers were "virtually extinct" in Missouri by approximately 1915. They probably were gone from Ozark County before 1900, for none of the old residents can remember them. In 1928 beavers were reestablished on Current and Meramec rivers in the eastern Ozarks by importations from Minnesota (Bennitt and Nagel, *op. cit.*). In 1937 and 1938, seven live-trapped animals were moved from Meramec River to Spring Creek, eight miles southwest of Willow Springs, Howell County. A thrifty colony now is established there (14 new dams were observed in 1942), and the local population has spread to adjacent streams. In 1939 a small colony was discovered at the junction of Fox and Bryant creeks in Douglas County, five miles north of the Ozark County line. This colony presumably originated from the population on Spring Creek. If the beavers reached the site in Douglas County by water-way, they traveled at least 75 miles, much of the route being in the northeastern corner of Ozark County. Reestablishment of the species in Ozark County, through spread of these nearby colonies, is anticipated. On Spring Creek, the principal foods utilized by the beavers seem to be red and white oaks, various dogwoods (*Cornus*), serviceberry (*Amalanchier canadensis*), willows (*Salix*), and "ironwood" (*Carpinus*). Abundant supplies of sycamore are left untouched.

Reithrodontomys fulvescens aurantius Allen. Golden harvest mouse.—One was trapped in a wheat shock five miles north of Gainesville, which provides a record station of occurrence about 100 miles east of Carthage, Missouri, and the same distance northeast of Winslow, Arkansas, which are the easternmost places in this latitude from which Howell (N. Amer. Fauna, no. 36, p. 48, 1914) and Black (Jour. Mamm., vol. 17, p. 33, 1936) previously have reported the species.

Peromyscus leucopus noveboracensis (Fischer). Wood-mouse.—Five specimens were saved, all of which were taken around a limestone ledge in moist woodland on Caney Mountain Refuge.

Sigmodon hispidus hispidus Say and Ord. Cotton rat.—Four specimens were trapped five miles north of Gainesville and a fifth in the town of West Plains, Howell County. So far as is known to us, the species has not before been recorded from Missouri. Until the

races of the species are revised, we tentatively assign these specimens to the subspecies *hispidus*. All individuals taken were in fields of mixed broom sedge (*Andropogon virginicus*) and Korean lespedeza.

Neotoma floridana osagensis Blair. Florida wood rat.—On Caney Mountain Refuge, these rats were found living in crevices in a limestone cliff and also in an abandoned barn. In the loft of the barn, several specimens were trapped in tunnels and runways under a pile of corn fodder. On April 16, 1942, four rats were seen hastily leaving this pile of fodder, from which there presently emerged a coachwhip snake (*Coluber flagellum*) about six feet long; the snake was judged to have caused the disturbance among the rats. A pile of seed pods of honey locust (*Gleditsia triacanthos*) eighteen inches high and twice as wide at the base was found on a platform in the barn. A female rat was trapped at one of the three tunnels entering the pile of pods. A pile of sticks, apparently made by wood rats, was observed in a crevice in the cliff mentioned above.

The name *N. f. osagensis* Blair (Occas. Papers, Mus. Zool., Univ. Mich.; no. 403, p. 5, 1939) is tentatively applied to our six specimens. Before Blair proposed the name *osagensis*, this rat would have taken the name *N. f. attwateri* Mearns (see Goldman, N. Amer. Fauna no. 31, p. 26, 1910).

Pitymys nemoralis Bailey. Woodland vole.—Five specimens were trapped in their characteristic subfossorial runways, from 30 to 200 feet away from the edge of the timber in a field of rather dense and ungrazed Korean lespedeza. No voles or their runways were found elsewhere, although looked for in adjoining areas of woodland and in ungrazed bluegrass fencerows.

Ondatra zibethica. Muskrat.—Although not abundant in the County, some muskrats are taken each winter by trappers along North Fork River and Bryant Creek.

Rattus norvegicus. Norway rat.—Abundant around farm buildings.

Mus musculus. House mouse.—Abundant around farm buildings. One specimen was taken October 19, 1941, in a wheat shock more than a mile from the nearest house.

Lepus californicus. California jack rabbit.—Many reports have been received of jack rabbits occurring on the flat ridgetops (formerly prairie) in north-central Ozark County, and in December, 1941, their tracks were seen five miles east of Rockbridge. This point is 30 to 40 miles farther east than the easternmost place from which Bennitt and Nagel (*op. cit.*, p. 95) found jack rabbits a decade ago.

Sylvilagus floridanus. Florida cottontail.—Generally common, although there are local fluctuations in numbers from year to year. The winter of 1942–43 was a year of relative scarcity of cottontails on Caney Mountain Refuge.

Sylvilagus aquaticus. Swamp rabbit.—Present in small numbers along North Fork River in the southeastern part of the County, as at a point three miles southwest of Udall. The construction of a flood control dam in Arkansas, which will inundate the bottomlands along North Fork River 15 miles up stream into Missouri, may eliminate the species from Ozark County.

Odocoileus virginianus. White-tailed deer.—In the memory of old residents, deer were exterminated in Ozark County in about 1908. They have persisted, however, in Taney County, which adjoins Ozark County on the west. From 1936 to 1938, approximately fifteen deer, obtained in part from the zoo in Springfield, Missouri (allegedly pure Missouri stock), and in part from Skaggs Ranch in Taney County (mixed native and Wisconsin stock), were released on Blue Spring Refuge in northeastern Ozark County. In 1940 and 1941, 30 more were brought in from Skaggs Ranch and released on Caney Mountain Refuge. Both herds are now well established. In 1943 there were estimated to be at least two hundred deer in the County, derived from these two introductions.

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A SUGGESTED HOMOLOG OF THE OS PENIS OR BACULUM OF MAMMALS

By W. L. Jellison

Attention is being given in current taxonomy to a peculiar osseous structure in the male genitalia of mammals and extensive study collections of these ossicles are being accumulated at several museums. The taxonomic value of this bone was early recognized and used in many papers by Oldfield Thomas who proposed the name "baculum or little stick" for the structure. Its presence in the fox, wolf and martin are even mentioned by Aristotle. There has been some conjecture as to the derivation of this bone which in its present form is isolated from the appendicular and axial skeleton. The general assumption appears to be that it is comparable to the other isolated bones such as the os cordis found in the ox and the os diaphragmatis of the camel (Ruth, 1934). However, some evidence suggests this bone may be derived from the appendicular skeleton.

The baculum is present in many genera of Chiroptera, Insectivora, Carnivora, Pinnipedia, Primates and Rodentia but seems to be absent in the Lagomorpha, Artiodactyla and Perissodactyla. According to the classification of mammals proposed by Miller and Gidley (1938) it is present in the more generalized Orders of living placentate mammals and absent in the most specialized orders. A marked exception is its reported presence in whales (Kingsley, 1912; Ruth, 1934). This distribution would indicate that it is a primitive and not a specialized structure. A rudimentary bone is present in the clitoris of at least the following genera; *Aplondontia*, *Cryptomys*, and *Lutra* (Scheffer, 1942); *Hystrix* (Weber, 1927); *Procyon* (Rinker, 1944); *Ursus* (observation of the writer); *Cryptoprocta* (Lönnberg, 1902); *Putorius* and *Ictis* (Pohl, 1909); *Hemigalago* and *Meles* (Pocock, 1918). It will probably be found in the females of many more genera where the structure is well developed in the males. This occurrence in the female is also interpreted as evidence that the ossicle is not a specialized or recent development in mammals having appeared spontaneously in various Orders, but that it is a common inheritance remaining functional or vestigial in some species and having disappeared entirely in others. The regularity of its occurrence in entire families of mammals and the constancy of its morphology within genera and species, qualities which make it a reliable taxonomic character, also suggest the antiquity of its origin in the vertebrates.

No such structure appears to be present in the genitalia of Monotremata or Marsupialia. Examination of numerous well prepared skeletons of both these Orders in the Chicago Natural History Museum, June 1941, and in the United States National Museum, June 1944, failed to reveal any such ossicle. It is admitted that preparators might overlook and discard such a small piece as they have done rather consistently with the baculum in the preparation of other mammal skeletons. Ruth (1934) states it has been recorded for Marsupialia but specific data on this have not been found. The Monotremata and Marsupialia do have the epipubic or marsupial bones, paired fingerlike bones attached to the anterior ventral rim of the pelvis. These bones are not found in the true placental mammals.

A homology between the epipubic bones of the Marsupialia and the os penis of other mammals is suggested by the developmental stages found in *Canis*. In this genus the os penis starts as two distinct lateral splints very similar in size and shape to the epipubic bones of *Perameles*, a marsupial. These two splints later fuse into a single strong median shaft. A specimen from a fox hound pup 28 days old shows the initial fusion of these lateral splints. The dog also possesses two distinct corpora cavernosa (Sisson, 1930). Rinker (1944) suggests that this development from two centers of ossification occurs in *Procyon*, but apparently did not observe the early unfused stages. In some mammals, as *Aplodontia*, an original division of the ossicle is suggested by the deep bifurcation of the mature bone.

If this homology is correct there should be some antecedent in the pelvic anatomy of fossil or living reptiles. Kingsley, in "The Comparative Anatomy of the Vertebrates," 3rd edition, states in regard to the marsupial bones, "Their homology is very uncertain." Yet Gregory and Camp (1938) refer without reservation to the "marsupial bones" in *Cynognathus*, an extinct reptile that is often considered an ancestor of the mammals.

The writer is indebted to Karl P. Schmidt and Dwight D. Davis of the Chicago Natural History Museum, and to Remington Kellogg and H. Harold Shamel of the United States National Museum, for the privilege of examining specimens in their respective institutions. A study of the baculum of mammals was initiated under the direction of Milo H. Spaulding at Montana State College in 1928.

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STRUCTURE AND FUNCTION OF THE BRAIN OF THE OPOSSUM (*DIDELPHIS VIRGINIANA*) AT THE TIME OF BIRTH

By W. Riese

The developmental stage the mammalian central nervous system may reach at the time of birth is not the same in the various species, the most variable region being the cerebral cortex (Riese, 1944). *A mammal can be born at any stage of cortical development*, ranging from the still unstratified cortical layer in the new-born bear (*Ursus arctos* L.) (Riese, 1942) to the practically finished cerebral cortex of the human infant showing all of its regional variations at the time of birth (Conel, 1939, 1941). In spite of the great variation in their cortical development at the time of birth, all of the mammals must meet the requirements of extra-uterine life. Little is known about the developmental stages the constituent elements of the central nervous system (fibers, cells) may reach in the various species at the time of birth. Although there are numerous species in which the *morphological* (convolutional) pattern of the brain is already finished at the time of birth (ungulates, some carnivores, man), there is no species in which the process of *histological* maturation would have come to its end at the time of birth at all of the levels of the central nervous system. In the most immature brain hitherto described in a new-born mammal, *i.e.* that of the new-born bear (Riese, 1942), maturation of nerve cells is obvious in lower levels, but does not reach beyond the midbrain.

The results of this investigation are based on the study of four new-born opossums, two of which measured 11 mm, one 10 mm, and one 9 mm, crown-rump length. Two specimens were given by the Wistar Institute, Philadelphia. I was further given the opportunity by Dr. A. A. Zimmermann, Professor of Anatomy, University of Illinois, College of Medicine, Chicago, to study his own material. Included in this study are one prenatal stage, about 24 hours before birth, and one pouch young opossum, 22 mm crown-rump length, both being specimens of the collection of Dr. A. A. Zimmermann. I wish to express my gratitude to the Wistar Institute, to Dr. Zimmermann, and to Dr. E. C. L. Miller, secretary of the Virginia Academy of Science.

THE BEHAVIOR OF THE NEW-BORN OPOSSUM

The opossum is born at the end of a gestation period of only about $12\frac{3}{4}$ days. The new-born averages about 11 mm in crown-rump length. The original theory, according to which the mother transfers the young from the vulva to the pouch by means of her lips, has been abandoned since the careful observations of Carl G. Hartman (1920), confirmed by Edward McCrady, Jr. (1938). It can now be accepted that the new-born opossum travels by its own efforts. It reaches the pouch of its mother by crawling movements which are described by McCrady as follows: "They begin with the lateral flexion of the head and neck followed closely by the forward movement of the ipsilateral foreleg. The head then starts a flexion toward the opposite side while the claws of the forefoot close

in a clasping movement and the foreleg is moved backward in an effective propulsion stroke. The caudal end of the body is then flexed as a whole toward the side on which the effective stroke of the forelimb is being executed. This constitutes a complete cycle. A similar cycle is initiated on the contralateral side when the head moves in that direction. The whole cycle seems to represent a wave of contraction which starts at the anterior end of the body on one side and travels posteriorly, the similar wave of the opposite side starting before the first wave has progressed beyond the anterior limb". The author then continues to describe the attachment to the nipple: "When the young enters the pouch he finds himself in a maze of tangled, curly hairs, among which he must locate one of thirteen tiny mammary nipples—about the size of the head of a common straight pin. The sensory equipment which he has to assist him in this search, is very scanty indeed . . . . and perhaps the most amazing thing that he does is to succeed in this search; but once in the pouch, he is almost certain to do so. I have watched them do it many times, and I do not yet know what clues they use, certainly not sight, possibly smell, possibly cutaneous sensations of warmth, moisture, and touch. The head is moved in wide excursions to right and left, and when the snout finally touches the soft, moist, and warm nipple, the wandering stops and the young promptly sucks the nipple into its mouth". There is no assistance on the mother's part, other than to free the new-born of liquid on its first emergence into the world. Immediately upon release from its liquid medium, this new-born opossum, "in appearance more like a worm than a mammal" (Hartman), is able to crawl a full three inches over a difficult terrain. After the young opossum had become attached to its mother's mammary nipple it cannot detach itself for some fifty days. During this interval the development of all its organs goes on.

THE STRUCTURE OF THE BRAIN OF THE NEW-BORN OPOSSUM

The developmental stage of the central nervous system of the new-born opossum corresponds to the earliest stages of human embryos studied by Hochstetter (1919), and by Kodama (1927), and to those of cat embryos studied by Tilney and Kubie (1931), (namely to the 1.5 cm human embryo described by Kodama, to the 12.88 mm human embryo of Hochstetter and to the 10 mm cat embryo of Tilney and Kubie). At this stage the wall of the neural tube is composed of three layers, ependymal layer, mantle layer, and marginal layer. This is exactly the structural plan of the hemispheric wall of the new-born opossum (Plate 1, upper). In some (lateral) regions the mantle and the marginal layers can hardly be separated from one another, so that here the hemispheric wall seems to be composed of only two layers. There is no cortical layer as yet. The hemispheric wall is extremely thin. A slight intraventricular protuberance of the basal regions (eminentia ganglionaris) indicates the anlage of the basal ganglia. The area chorioidea is well marked in the end brain of the new-born opossum and the plexus chorioideus of the fourth ventricle is already differentiated. All of the divisions of the neural tube are well delimited (diencephalon, mesencephalon, rhombencephalon). Beginning at the level of the midbrain and

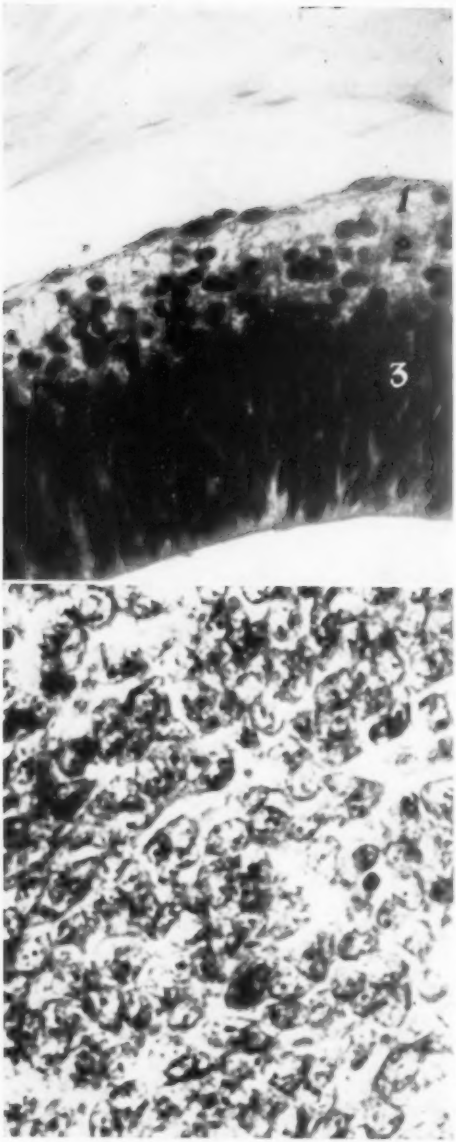

PLATE 1

UPPER: Hemispheric wall of 11 mm opossum at birth. Frontal section, A. Z. 1935, slide no. 4, H. and E. stain, × 600. 1. Marginal layer, 2. mantle layer, 3. ependymal layer.

LOWER: Spinal cord of 9 mm opossum nine hours old (Wistar Institute). Nissl stain, × 720.

reaching to the spinal cord, the wall of the neural tube becomes markedly thickened, this thickening affecting primarily the mantle layer. In spite of this thickening of the brain wall in lower levels, the three layer type remains unchanged throughout the entire neuraxis. The hypophysis has already attained a considerable size, showing its two divisions, namely neuro- and adeno-hypophysis and the hypophyseal cavity. The entire ventricular system (including aquaeductus Sylvii and central canal) is extremely large. The nuclei of the cranial nerves stand out very prominently. The cerebellum, being the only division of the central nervous system of the new-born opossum submitted to a previous study (Larsell, 1935), is at the plate stage. In the spinal cord (cervical level) one can easily distinguish the three gray columns, roof plate, floor plate, the still elongated central canal lined by the cells of the ependymal layer, the marginal zone (containing the tract beds) and the ventral commissure. The spinal ganglia are organs of considerable size. There is a suggestion of cell grouping in the spinal cord. The largest and most mature elements are to be seen in the ventro-medial and ventro-lateral regions. In Nissl-stained sections (Plate 1, lower) the cells are closely packed; they show various shapes, their outlines are still indistinct, they have a large almost unstained nucleus, provided in its turn with two or more nucleoli. The cytoplasmic body is very small, it stains deeply but diffusely and no distinct Nissl granules are recognizable as yet. No cell processes can be seen. There are some minor individual differences between the various specimens submitted to this study. They concern primarily the developmental stages of the plexus chorioideus of the forebrain and of the primordium of the basal ganglia; both structures may be somewhat more advanced than described above.

DISCUSSION

The outstanding feature in the brain of the new-born opossum is the total lack of cortical structures. The opossum is the only mammal born without a cerebral cortex or its primordium (lamina granularis primaria). It shows the most immature stage of brain development ever seen in a new-born mammal. In spite of this very immature central nervous system it accomplishes all of the functions necessary for extra-uterine life (respiration, thermo-regulation, circulation, metabolism, excretion, etc.). But the motor behavior of the new-born opossum seems to be merely a metameric pattern and might thus perhaps be interpreted as a spinal mechanism, not yet requiring the cooperation of higher levels of the central nervous system. Then the problem comes up whether the spinal cord of the new-born opossum, although still embryonic in its morphological plan, possesses already the structural elements generally believed to be indispensable for nervous function. Myelin sheaths, neurofibrils and nerve cells are supposed to be these elements. No myelin sheaths are present as yet in the central nervous system of the opossum at the time of birth; the first myelinated fibers appear in a 44 mm pouch young opossum (Langworthy, 1928). Therefore, nervous functions taking place in this animal at the time of birth cannot appeal to myelinated fibers as to indispensable structural elements. No data

are available as to fibrillation. Generally speaking, the development of collaterals of the dorsal funiculus has been correlated with the appearance of the first forelimb reflexes (Windle, 1940). However, a close correlation of functional activity with definite structural elements is not admitted unanimously (Gonzales, 1939). As to *nerve cells* we may assume that in all probability the lateral zone of differentiation we could distinguish in the spinal cord of the new-born opossum is related to the muscles of the forelimb, whereas the medial one is related to those of the neck or trunk. According to the only study made so far of the developmental stage of the individual cells of the spinal cord in non-motile and motile stages (Romanes, 1942), the first signs of functional activity coincide with the appearance of Nissl granules. This holds true for the rabbit. But my investigations show that in the new-born opossum no Nissl granules have appeared as yet. The developmental stage the nerve cells have reached in this animal at the time of birth must be designated as *neuroblast*. The motor behavior of the new-born opossum must therefore be correlated with this early stage of cell maturation.

CONCLUSIONS

1. The opossum is born with a central nervous system recalling the earliest stages of brain development. No cortical structure is formed so far.

2. The structural plan of the central nervous system of the new-born opossum corresponds approximately to that of a human embryo of about the same length. The human embryo reaches this stage at the age of about 6 to 7 weeks, the opossum after a gestation period of about $12\frac{3}{4}$ days. This confirms a previous statement (Riese, 1944) according to which the developmental stage a given nervous system may reach at the time of birth is not in proportion to the gestation period.

3. In spite of its immature nervous system the new-born opossum does not only survive and therefore accomplish all the functions indispensable for extra-uterine life, but it displays also a complicated and purposeful motor activity being at the service of the search for the nipple of the mother.

4. The motor behavior of the new-born opossum interpreted as a spinal mechanism has to be correlated not only with an immature spinal cord as a whole but also with immature nerve cells (neuroblasts).

5. The fact that a sustained extra-uterine life and motion are possible in very immature nervous systems (bear, opossum) cannot be overlooked in any attempt to correlate nervous function with nervous structure.

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NOTES ON THE DISSECTION OF TWO DUGONGS

BY W. C. OSMAN HILL

Apart from some remarks of Kükenthal (1897, 1914), little or nothing seems to have been added to our knowledge of the anatomy of the dugong (*Dugong dugung*) since the classic account of Owen (1838), which was summarized in appropriate sections of his later monumental Comparative Anatomy and Physiology of Vertebrates (1868). More has been done, however, with its Atlantic relative the manatee (Murie, 1872; Miklucho-Maclay, 1881; Beddard, 1897; Wislocki, 1940). The opportunity recently afforded to me of dissecting both a male and a female dugong enables me to assemble the subjoined notes, which are merely intended as preliminary to a more detailed study of the more interesting organs that were preserved.

Dugongs are quite commonly captured by fishermen off the northeastern coasts of Ceylon, but their flesh is so valued as an edible commodity, especially by Muslims, whose religion forbids them to eat the flesh of the pig, but apparently gives them free license with the "sea-pig" (in Sinhalese the animal is called *muda ura* and in Tamil *cuddal pandi*, both signifying "sea-pig"), that material for anatomical use is hard to come by. After fruitless endeavor, extending over a period of 12 years, to obtain so much as a few odd bones or viscera, I was at last rewarded with the opportunity of personally dissecting and dismembering

two adult (or subadult) animals in the Pettah fish market, Colombo, within a month of each other. Luckily they were of opposite sexes.

The animals are brought to the Colombo market alive. They are inert, helpless creatures that, out of water, flounder about by up and down strokes of the tail, aided by rather futile activities of the flippers. The only other mobility observed was the closing and unclosing of the eyelids and prominent nictitating membranes and the excursions of the mobile, fleshy lips.

The animal is, for the market, literally butchered alive. No special slaughter is arranged, and instead of cutting its throat—an operation that would involve the trouble of turning its ventral surface upwards—the butcher simply takes a sharp carving knife and (commencing dorsally) severs the head from the trunk immediately behind the skull! To avoid damage to the visceral structures of the neck, I took over the dissection after the butcher had disarticulated the alanto-occipital joint, and thereafter carried out all the main dissection in the case of the male. In the second example the butchery had already progressed too far for this. I had to content myself with the resection of the female genitalia, kidneys, etc. and a confirmatory exploration of the other organs, and their removal for subsequent study.

PHYSIOLOGICAL OBSERVATIONS ON THE ENTIRE ANIMAL

Apart from the movements noted above, it may be observed that all muscular activities were sluggish, including respiration, which was spasmodic rather than regular, due, no doubt, to the abnormal environment. The action of the tail muscles in the up and down movement of the flukes was very powerful.

The temperature of the surface of the body was not appreciably higher than that of the surrounding air, but the deep tissues were quite warm. The fat was semisolid with a characteristic but non-fishy odor. There was no free oil as was also noted in the manatee by Murie (1872).

Bleeding was insignificant unless large vessels were opened.

EXTERNAL ANATOMY

A few points need be added to the already known facts.

The muzzle (Plate 1 and figs. 1 and 2).—This is the most peculiar region. It strikes one as a truncated proboscis rather than as a modified upper lip. It presents two surfaces; dorsal, continuous with the forehead, and antero-ventral. The two are separated by a strongly arched or crescentic border. The dorsal surface is smooth and convex from side to side and bears the valvular external nares, which lie close together (16 mm apart in the male) near the crescentic border. They resemble the blow hole of a whale, except that they are paired instead of median. They appear as if a thumb had been pressed onto the skin and depressed a circular area, leaving a firm, rounded, crescentic rim posteriorly. They have a diameter of 18 mm. The antero-ventral or facial aspect of the muzzle is flat, bordered above and at the sides by the crescentic border. Below it is slightly notched in the middle, but more deeply cleft laterally, beyond which the most lateral part descends as a rounded lobe guarding the mouth. The semilunar surface is marked by a slight irregular median sulcus in its central portion; more strongly marked lateral sulci run parallel to the lateral borders some distance medial thereto. This surface is beset with numerous horny spines of various sizes. The larger ones resemble small porcupine quills but the smallest are more like short stiff hairs. They are the only representatives on the animal of a pilous system, except for some minute bristles on the chin, on the dorsal surface of the animal, and around the anus and genital openings, but both macroscopically and micro-

scopically all these are typical mammalian structures. They are readily pulled out as they are not deeply set in the skin, only about one-third or less of their length being intracutaneous. They are slightly bowed, with their concavities towards the oral margin. Their roots are swollen and funnel-shaped with the hollow of the funnel extending some distance into the free part of the shaft. Structurally they consist of yellowish-brown cortex and an inner white pulpy substance corresponding to the medulla of a hair. At the root the outer, horny layer is much thinned and the medullary portion correspondingly

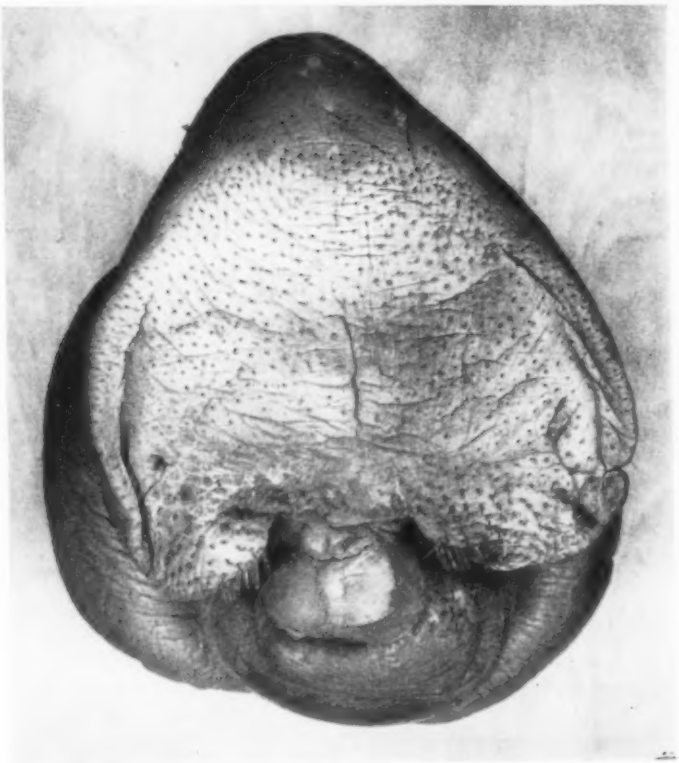

PLATE 1

Photograph of muzzle of a male dugong, in anterior view, showing distribution of bristles and relations of structures around oral opening.

thicker (see fig. 1). The spines are, therefore, simpler in structure than those of hedgehogs or porcupines. Fundamentally they would appear to serve as horny teeth similar to the lingual teeth of the Felidae, and are probably used in rasping off seaweed from rocks and assisting it into the mouth. The largest spines grow from the inferolateral parts of the muzzle. Smaller ones occupy the median portion of the true upper lip. The central parts of the muzzle are sparsely supplied, but they become more densely planted again towards the periphery, except at the extreme upper region, near the nostrils, where they are completely lacking.

The Mouth.—This is a relatively narrow, transverse, slit-like opening guarded above, not by the upper lip directly, but by the projecting upper alveolar gum, and below by the thick, fleshy lower lip (see fig. 2). The upper gum forms a dumbbell-shaped projection (60 mm from side to side) separated from the true upper lip or median part of the rhinarium by a broad, shallow alveolo-labial sulcus. Below this sulcus, the covering membrane is softer than elsewhere and is thrown into a few horizontal folds; but there is no fraenum. The rest of the alveolar prominence is covered with hard, horny mucous membrane and lies immediately upon the bone.

The lower lip is divided into a muco-cutaneous or "red" portion and a cutaneous one. The former is smooth and without pilous appendages, but the cutaneous part, which is separated from it by a transverse sulcus, is provided with bristles, scarcely different from

Fig. 1

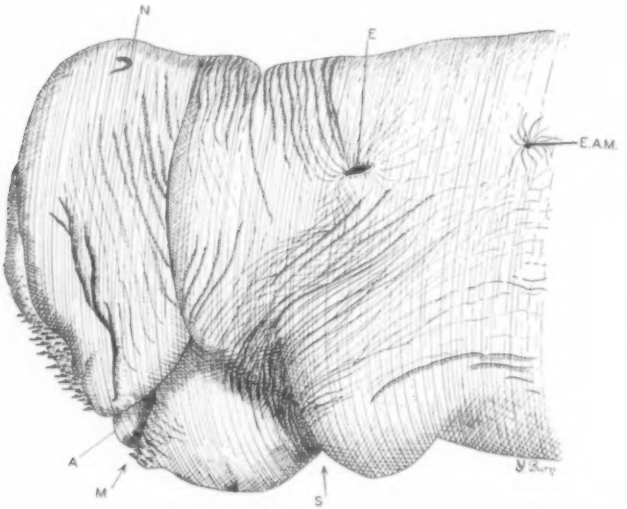

Fig. 2

Fig. 1. Longitudinal section of a facial bristle of the dugong. C., cortex; M., medulla.
Fig. 2. Side view of a head of a male dugong.
A., alveolus of upper jaw; E., eye; E.A.M., external auditory meatus; M., position of mouth; N., anterior naris; S., sulcus mentocervicalis.

ordinary mammalian hair. On the contrary, beyond the red margin, on the truly mucuous part of the lower lip, there occur some of the largest spines of all, larger even than those on the inferolateral lobes of the muzzle.

The cutaneous part of the lower lip clothes the mandible uninterruptedly as far back as the chin, which is separated by a very deep mentocervical sulcus from the neck.

The angles of the mouth are deeply hidden by the overlapping of the inferolateral lobes of the muzzle and a lobe of skin that is morphologically derived from the cheek. These two are separated, on the face, by a deep nasolabial sulcus. The other finer cutaneous sulci, which appear to be produced along the lines of flexion of the skin, are indicated on figure 2. Note the criss-crossing near the lower eyelid and in the neighborhood of the external auditory meatus; their complete absence from the region round the external nares.

Ocular region.—The upper and lower eyelids are short, thick and surround a relatively small palpebral opening (10 mm long). But the nictitating membrane is well developed,

and the conjunctival sac much more extensive than would be expected from the size of the lids. All three lids are very muscular, but the closure of the sac is largely the duty of the nictitating membrane.

External auditory meatus.—This is a minute opening situated 97 mm behind the posterior canthus and in direct line with it. It is unguarded by any dermal flap. It admits a probe for 28 mm.

Nipples.—These are two in number only, situated in the axilla. They are pink in color and project 25 mm in the non-pregnant female.

Urogenital openings.—In the male there is a single preputial orifice situated half way between the umbilicus and the anus. It is a round opening with puckered margins, and, like the umbilicus and anus, is surrounded by paler, more pinkish skin than that of the neighboring parts. The preputial space discharged a dead fish on being opened up. This suggests a state of commensalism similar to the well-known instance of *Fierasfer* in the

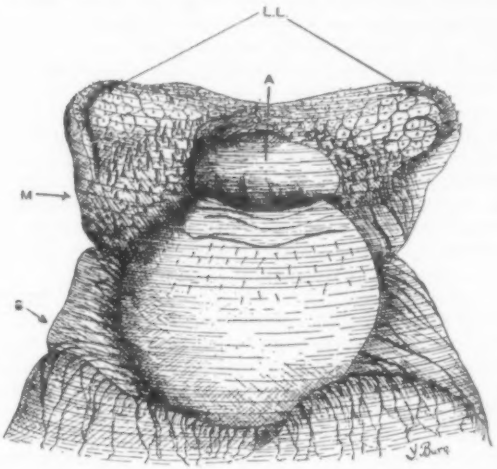

FIG. 3. Ventral view of head of a male dugong. L.L., lateral lobes of muzzle. Other references as in fig. 2.

cloaca of the sea-cucumber. The fish had probably died when the dugong was taken out of the water. It is inconceivable that a fish got there after its own death or the dugong's capture. Details of the penis and neighboring parts are discussed with the reproductive organs below.

The female appears superficially to be provided with a single, elongated, slit-like opening 115 mm long, with the margins of its most anterior portion pushed apart by a protruding glans clitoridis of ample proportions. Careful examination, however, proves this appearance to be deceptive. Actually the long slit is composed of two shorter slits placed in line, one behind the other, separated by a "perineal body" of 28 mm thickness. But the perineal body is provided on its cutaneous aspect with a median sulcus joining the vulval cleft with the anal cleft.

The vulval cleft lodges not only the large, conical glans clitoridis, which measures 32 mm craniocaudally, but also a large triangular urethral caruncle, which lies immediately behind it. The urethral orifice opens posteriorly to the caruncle, separately from the vagina, which is a larger opening, provided along its hinder margin with a thin semilunar fold resembling the fourchette of human anatomy (see fig. 5 B).

Anus.—The anus is a tightly closed, puckered opening, situated in the mid-ventral line about one-third the length of the animal from the extremity of the tail.

Pectoral limbs.—The pectoral limbs form the flippers, which differ from those of cetaceans in their possessing an externally demonstrable elbow joint. The hand is a flat object formed on a basis of five bony digits, but possessing no external indication of them. No signs of nails was detected on either specimen. The digital formula is: IV — III — II — V — I. There are several osteological differences from the statements given by Owen (1868) and Flower (1870).

There is no external evidence of pelvic limbs or girdle.

SUPERFICIAL DISSECTION

The skin is thick—up to 20 mm. The greater part of its thickness is due to the white fibrous corium; the pigmented epidermis constituting $\frac{1}{20}$th of the total thickness. It rests upon and structurally passes into the underlying fatty subcutaneous layer of blubber. This is not so thick as in cetaceans, but is composed of similar tissue—firm, white, oily fat with a slight odor. It contains a goodly amount of dark panniculus carnosus.

Deep fascia is well-marked and covers the dark reddish body muscles. These are readily stimulated to contract by the passage of the knife, but their movements are slow and rhythmic; they retain their vitality for a considerable time after death. They still responded after being removed from the body and transported to the laboratory—a distance of 4-5 miles from the market. I took the opportunity of testing the culinary qualities of the flesh. It is certainly very palatable, but resembles beef of rather fine texture more than pork. It has no suspicion of fishy flavor. A study of the microscopic structure of the muscle has already been made and offered for publication elsewhere. The main point is that it consists chiefly of the primitive type of fibres termed "red" by histologists.

GENERAL DISPOSITION OF THE VISCERA

There is scarcely any neck, so that the thorax and its contents follow almost directly on the floor of the mouth—a retained embryonic feature. Thus there is scarcely any trachea, the respiratory passages bifurcating almost immediately caudad to the larynx.

The thorax is roomy, but of peculiar shape, similar to that of the elephant, but more exaggerated. The diaphragm is set almost horizontally, instead of vertically, on account of the extreme obliquity of the caudal aperture of the bony thorax. This allows the lungs to extend backwards in the hollow formed by the ribs on either side of the vertebral column. They extend caudally beyond the upper part of the kidneys. They are flattened, leaf-shaped organs recalling those of reptiles rather than mammals and present dorsal and ventral surfaces and medial and lateral borders. Their ventral surfaces are covered by a firm membrane, which anteriorly fuses with the dorsal wall of the pericardium, thus forming a very firm, fibrous partition between these parts of the lungs and the heart. The heart itself occupies a relatively small part of the thorax, and is guarded ventrally merely by the thinner ventral part of the pericardium and the short, stout sternum. It is a very primitive organ, globoid in shape and with a deeply incised apex; the two ventricles are separated almost to their roots on the auriculoventricular fibrous rings.

The abdomen is a conical cavity, broad anteriorly and narrowing to an apex behind. Its anterior wall is formed by the ventral part of the diaphragm, which is here composed of an extensive central tendon. The diaphragm also contributes largely to the dorsal abdominal wall for the reason mentioned above. Caudad to the kidneys, the dorsal wall of the belly has the usual arrangements. The pelvic parietes, of course, are largely composed of soft tissues only. The general disposition of the abdominal viscera is not unusual. Liver, stomach and spleen have the usual relations. The small intestine occupies the center of the cavity and is surrounded peripherally by the large intestine, which is itself markedly coiled, especially on the right. Both parts possess mesenteries, which are thin, friable and devoid of fat, as is also the great omentum, which has the usual relations to the

stomach, but gains no colic or mesocolic attachment. The rectum passes straight back in the midline to the anus, and has the bladder and genital ducts lying ventrad to it. Other details are listed below under appropriate systemic heading.

ALIMENTARY SYSTEM

Buccal cavity.—The palate extends back from the projecting alveolar process, which bounds the mouth superiorly, to the pharynx, where it ends in a thick, fleshy soft palate provided in the midline with a well-marked, conical, horny uvula. The hard palate is divisible into two regions, an anterior rugose area and a posterior tuberculated region, occupied by numerous, large, closely set, rounded prominences. This is succeeded by the smooth soft palate, but the hinder part of this also shows some evidence of tuberculation. There are numerous crypts that act as ducts for mucous secretion. In the angle between the palate and the side wall of the pharynx, neighboring the origin of the palatoglossal fold, is a short, stout, conical, horny projection. It is directed backwards and medially and is evidently the same as that referred to by Owen (*op. cit.*) as an outgrowth from the tongue.

The floor of the mouth is very narrow on account of the smallness of the space between the mandibular rami. It is largely made up of fat upon which rests the tongue and prehyoid musculature.

The tongue is similar to that of the elephant in topographical relations, for the posterior part of its morphologically buccal portion is set vertically, in line with the pharyngeal part, but it is blunt and slightly bifid anteriorly instead of pointed. It is feebly mobile, but in surface appearance resembles a typical tongue more closely than does that of the elephant. The buccal portion is beset dorsally with large, shaggy filiform papillae. They are stained a dirty green from the juices of seaweed. The sides and under surface of the tongue are smooth, except for a narrow strip beneath the free margin anteriorly. This strip bears filiform papillae and beneath them is a horny, smooth strip resembling a nail and closely reminiscent of the nail like structure in the same position on the tongue of graminivorus parrots. Opposite the region usually occupied by foliate papillae are some dozen deep pits, like pin-holes, but no surface projections. Similar pits, fewer in number and somewhat wider spaced, occur just behind the insertion of the palatoglossal fold on the pharyngeal portion of the tongue.

The circumvallate papillae seem to be represented by three rudimentary structures near the mid-line at the junction of the oral and pharyngeal portions of the tongue, but there are also some similar structures just anterior to the foremost group of pits referred to above on the sides of the tongue. There are no fungiform papillae. The horny excrescences described by Owen on the tongue are located on the palate (*vide supra*).

The pharyngeal aspect of the tongue appears very deep craniocaudally, but this is due to the inclusion of a portion of the morphologically buccal region, which is beset with filiform papillae, smaller than those in the fore part of the organ. These are succeeded by rudimentary circumvallate papillae, which lie in an irregular horizontal line joining the palatoglossal folds. Below them there is a region of small transparent tubercles, but the rest of the area is smooth. A few irregular folds connect the lowest part with the mucous membrane covering the short, thick epiglottis. There are no true valleculae.

Salivary glands.—The parotid appears to be the only salivary gland. This is large. It occupies the usual position. Its superficial surface is flat and lobulated, triangular in outline, with the base above and the apex descending along the posterior border of the mandible. From its deep surface a process proceeds inwards between the neck of the mandible in front and the muscles attached to the styloid process and the mastoid region behind. This process passes deeply as far as the pharyngeal wall and is also directed backwards again thereon, so as to form almost a ring around the origins of these muscles.

The parotid duct is large and proceeds forward and slightly downward over the masseter to open into the mouth near to the gland.

The facial nerve and its branches lie wholly superficial to the gland.

Pharynx.—This region of the gut is relatively small. The nasopharynx is a very con-

stricted space receiving anteriorly the openings of the two posterior nares, which have fleshy margins and are evidently capable of some degree of constriction. The extensive soft palate separates it from the oropharynx, which is the largest part. Its anterior wall, formed by the tongue, is its most extensive region. The lateral walls bear no tonsils. Palatoglossal folds are present but palatopharyngeal folds were not observed. The laryngopharynx narrows down very rapidly to the oesophagus, being only about one inch long. The superior aperture of the larynx is of usual form, but the epiglottis is poorly developed for an aquatic animal, in great contrast to the condition seen in whales and seals (see Negus, 1928). Huxley's (1871) statement that the epiglottis is capable of covering the glottis is quite incorrect.

Oesophagus.—This is a very muscular tube, containing striated muscle fibres in its outer longitudinal and inner circular coats all the way down to the cardia. It contracts rhythmically and artificial stimulation causes synchronous peristaltic contractions on the pyloric caeca.

Stomach.—This organ has been very fully described by Owen and I can do little more than confirm his findings. It is a capacious globular viscus of simple form, except for a conical protuberance from the left hand extremity of the organ. The pyloric caeca, described by Owen as appendages to the stomach, are outgrowths of the duodenum, since they open beyond the pylorus. Owen described the conical cardiac protuberance as a glandular pouch, whilst Huxley merely refers to "a peculiar gland" in this position. Neither of these statements adequately explains the actual condition present. The prominence is not a pouch, since it is more solid than hollow, although it is glandular. It is chiefly composed of a glandular body about the size of a man's fist. It lies in the submucous layer and causes a wide separation between the mucosa and the muscular wall of the stomach. The latter is only about ½ inch thick over the gland, whereas in the rest of the stomach it attains almost one inch in thickness, being thinner at the pyloric end. The gland is a compound one and appears to be arranged like the leaves of a book; its more detailed study must be left for a later contribution. It bulges into the cardiac extremity of the gastric cavity in a manner similar to the bulging of the cervix uteri into the vagina, with a large *os*, capable of admitting the little finger, on the summit thereof. The gastric mucosa is thick, soft and elastic. It is readily separable from the muscle, the submucous connective tissue being soft and pliable. Rugae run, for the most part, longitudinally from the neighborhood of the cardiac orifice towards the pylorus. Two large parallel rugae, probably non-effaceable, border a groove on the lesser curvature running from the cardiac orifice toward the duodenum and corresponding to the gastric "duct" of ruminants. There are certainly two different structural regions of the gastric mucosa, a cardiac and a pyloric. The former has a pale yellow color in the formalin-preserved stomach, whereas the pyloric region is of a more greyish tint.

The portion of gut immediately to the right of the pyloric caeca, and which proceeds farther to the right for 5 or 6 inches, is most certainly duodenum, not a part of the stomach as described by Owen. It is separable by a distinct sphincter muscle from the true stomach.

The great omentum is small, failing to cover the intestines. It is devoid of fat, obtains no connection with the colon or its mesentery, and has, in general, retained very primitive (*i.e.* embryonic) attachments and relations. The lesser sac of the peritoneum is all but closed off from the general peritoneal cavity. Further details warrant special attention to which space cannot be devoted in a general account like the present.

Small intestine.—This is easily distinguishable from the large intestine by its thicker wall. This renders it paler in color than the large intestine, which appears dirty grey in color from the fact that its contents are partially visible through its thinner wall.

The duodenum is capacious, and its first part was included by Owen as part of the stomach. According to my interpretation, however, the pylorus is the annular thickening of the muscular coat situated just to the left of the roots of the pyloric caeca. From here the duodenum proceeds first to the right for 5 or 6 inches and then caudally for about the same distance, after which it narrows somewhat to become continuous with the jejunum, there being no special duodenojejunal flexure.

The caeca, two in number, one ventral and one dorsal, are elongated conical appendages with thick muscular walls growing from the duodenum immediately beyond the pylorus. They are of unequal length, the dorsal one being the larger. This one protrudes into the lesser sac; the ventral one grows into the greater sac. Between their roots the free edge of the lesser omentum is attached, carrying the common bile duct, which thereafter proceeds to the right between the origins of the two caeca to gain close relation to the cranial wall of the duodenum.

Large intestine.—This is disposed around the periphery of the small intestine. It consists of colon and rectum, the former possessing a conical caecum. There is, however, no very distinct division between colon and rectum. There are no taeniae coli or other external differences; the only distinction from small intestine being in the thickness of the wall.

The caecum has been well described by Owen, but it should be noted that the shape is variable according to the state of its muscle. When fresh, my male specimen had a caecum shaped exactly like Owen's figure, but after fixation it became more elongated. The apex is single instead of bifid, the condition found in the manatee.

The colon has "ascending", transverse and "descending" portions, all provided with mesenteries. The first named is the longest and is much coiled. The transverse forms a festoon across the widest part of the belly; the descending part is relatively straight and proceeds backwards, and, approaching the mid-line, passes imperceptibly into the rectum.

The anal canal is peculiar. The pale rectal mucosa is sharply demarcated from that of the anal canal along an annular line. The longitudinal folds are continued across this line, but in the anal canal they become finer and more numerous. The anal lining differs in its greyer appearance and harder texture. The line of demarcation lies over 50 mm within the anal margin. Just within the margin the longitudinal columns, of which there are about a dozen, suddenly increase in height, terminating in globular swellings, which assist in occluding the lumen and act as "anal valves".

Liver.—Owen's description of the liver is correct as far as it goes, but it is incomplete. Its chief peculiarities are its relations to other organs consequent upon the abnormal position of the diaphragm. The liver is flattened against the diaphragm by intra-abdominal pressure. At the same time it is transversely extended. As a result it presents comparatively little of its surface to inspection from the ventral side when the belly is opened, though sufficient is brought to view to disclose that it is divided into three main lobes—central, left and right. The falciform ligament and ligamentum teres proceed to the middle of the central lobe. On removal from the body a fourth, Spigelian lobe, is found situated on the dorsal border of the organ and closely attached to the posterior vena cava, which has the usual relation to the liver, but which is small in proportion to that of Man and does not present any post-diaphragmatic enlargement characteristic of the Pinnepedia.

Both right and left lobes possess low concial projections in relation to the cupolae of the ventral parts of the diaphragm, but dorsally they are more flattened where they are related to the lumbar extension of that organ. Both these lobes present similar lumbar extensions, resulting in completely altered relationships to the stomach and neighboring viscera. The dorsal wall of the "stomach bed", as well as its cranial wall, are thus comprised by the left lobe of the liver, while ventrally the stomach presents a correspondingly greater area of contact with the abdominal parietes.

The central lobe is the smallest of the three main lobes and is not distinct through the whole thickness of the organ, for the right and left lobes are connected by a thick bridge on its dorsal aspect.

The Spigelian lobe is small, quadrangular and practically unconnected by hepatic tissue with the rest of the gland. It is firmly adherent along its right border to the posterior vena cava. It is related to the oesophagus on the left, forming the right margin of the oesophageal notch.

The gall bladder is small and compressed into a strongly sigmoid form. It lies on the visceral aspect of the central lobe at about its middle. Its fundus fails to meet the posterior border of the liver. Its cavity is directed first to the right, then to the left, while

the cystic duct takes a final rightward direction in the porta hepatis. The falciform and round ligaments proceed on to the gall bladder instead of, as in Man, to the left of it; *i.e.* there is no "quadrate lobe".

The common bile duct, ¼ inch in diameter, proceeds in the free edge of the lesser omentum to the lesser curvature of the stomach, then turns to the right along the upper border of the pyloric segment, between the roots of the two pyloric appendages, and has a long course along the gut before opening into the duodenum, which it does into its second part in common with the pancreatic duct.

Pancreas.—This gland is relatively small in size, weighing only 29 gms. It is, in the main, a compact, lobulated gland, but there are some dispersed masses, disconnected from the main gland, lying along the course of the splenic artery as far as the hilum of the spleen between the layers of the dorsal mesogastrium. These are liable to be mistaken for pancreatic tissue, but microscopic examination reveals them to be lymphoid in structure. The pancreas resembles a human pancreas in shape, but the relations are reversed, for the apparent "head" lies to the left and the narrowed "tail" proceeds to the right, and from its extremity issues the main duct, which is almost as large as the bile duct, but thinner walled. Owen, too, noticed this narrowing towards the duodenal end of the organ.

RESPIRATORY SYSTEM

Nasal fossae.—The external nares have already been described. They lead into a nasal fossa which is disposed somewhat vertically, but details of their structure have not yet been studied as it was not considered warrantable to saw open the head with the limited material available. The posterior nares are small and separated by a very strong vomerine septum.

Larynx.—The epiglottis is short, thick and relatively immobile. It was correctly described by Owen and incorrectly by Huxley (*vide supra* under laryngopharynx).

The aditus laryngis is T-shaped, opening almost directly cranialwards. There are shallow, cleft-like pyriform fossae. Thyroid, cricoid and arytenoid cartilages are present. The cricoid is deeply excavated dorsally for the cricoarytenoideus dorsalis muscle. It also gives origin to a strongly marked and distinct cricopharyngeus muscle. There are no vocal cords. The aryteno-epiglottidean fold is well-marked. Below this the mucous membrane is closely apposed to that of the opposite side, forming a cushion-like prominence, broad dorsally, where it is supported by the medial surface of the arytenoid, but narrowing to an apex ventrally. This cushion represents the area occupied by both false and true cords in Man. Caudad to this narrow region of the larynx, the cavity broadens into a very capacious subglottic chamber.

Trachea.—This portion of the respiratory tract is very short and has only four cartilaginous rings in its wall. It is, however, very capacious having a transverse outer dimension of 42 mm and a dorsoventral measurement of 25 mm. The septum separating the two bronchi at the bifurcation of the trachea extends forwards within its lumen almost as high as the laryngeal chamber.

The thyroid gland is related to the ventral surface of the trachea.

Bronchi.—These are proportionately longer and stouter than in most mammals in correlation with the shortness of the trachea. The spiral nature of the cartilaginous "rings" has been confirmed. In the right bronchus the spiral descends with an anticlockwise direction. The first part of each bronchus runs caudally, parallel with its fellow near the midline, but as they approach the lungs they diverge to gain the ventral aspect of the corresponding lung, along which they course, somewhat nearer the medial than the lateral border, almost to the caudal extremity thereof, narrowing considerably in their most posterior third. The mucous lining is of a yellowish color and is thrown into fine longitudinal folds, rendering the tube dilatable.

Lungs.—Each lung is a dorsoventrally flattened, elongated leaf-shaped organ lying closely apposed to the inner surfaces of the dorsal parts of the ribs and intercostal muscles, and extending posteriorly as far as the kidney, from which it is, of course, separated by the

diaphragm. Of the two poles, the cephalic is narrow; the caudal, broader and more rounded. The hilum is situated on the medial side of the *ventral* surface a little posterior to the cranial pole. The ventral surface is marked by divisions of the bronchi and tributaries of the pulmonary veins. The dorsal aspect is smooth. Both surfaces are covered with closely attached visceral pleura, and a thin membrane also connects the inner margins of the two lungs across the mid-line, dorsad to the oesophagus, but ventrad to the aorta. There is no division of the lung into lobes and the borders show no notches.

At the hilum only the pulmonary artery actually enters the lung substance. This it does to the lateral side of the corresponding bronchus. The bronchus and the pulmonary vein, which lies to the medial side of it, both proceed caudally immediately beneath the visceral pleura. The tributaries of the vein cross the ventral aspect of the bronchial stem to open into the main vein.

Within the lung substance the arterial branches maintain a dorsal position with respect to the bronchi. The smaller bronchi are traceable to minute air vesicles by naked-eye dissection.

CIRCULATORY SYSTEM

Heart.—The general relations and form of this organ have been already referred to. There is plenty of subepicardial fat present, especially along the coronary sulcus and around the roots of the systemic and pulmonary aortae.

The atria are smooth-walled, simple cuboidal chambers presenting no appendages. Their walls are very thin. They show little indication of division into right and left externally, save for the relations of the associated vessels. The ventral wall of the atrial mass is deeply hollowed for the roots of the great arterial trunks. In its interior, the right atrium presents a smooth-walled portion or sinus venosus and a lateral portion with well developed musculi pectinati. Owen states that there is only one precaval opening, but Huxley maintains that there were two, in addition to the postcaval. The precaval veins were present in both my specimens, the left precaval being particularly large. This latter receives the coronary sinus just before embouching into the atrial chamber. It is guarded by a Thesbesian valve on its medial side. A Eustachian valve is also present guarding the postcaval orifice.

The interatrial septum is for the most part smooth and is somewhat obliquely disposed, its right aspect facing slightly dorsally. The fossa ovalis is reduced to a small deep pocket that admits the thick end of a porcupine quill for half an inch in a leftward and forward direction.

The left atrium receives a single pulmonary vein formed from the union of the two veins from the lungs. It proceeds ventrad to the left precaval to open into the right part of the atrium.

The ventricles are thick-walled, especially the left. Each has its own apex, widely separated from its fellow. The apposed surfaces are connected, near the bottom of the cleft, by a fold of epicardium. The tricuspid valve admits three fingers and the mitral two, as in Man. The cusps are short and broad. They are connected by chordae tendinae to short, thick but flattened papillary muscles, which are relatively small in size and have their roots on flying arches formed by enlarged columnae carneae. There is no true moderator band in the right ventricle, but there is a large columna carnea doing duty for it, and, like the papillary muscles, it is supported on flying arches, formed by other columnae at its ends.

There is a strongly developed crista supraventricularis in the right ventricle, and the division of the cavity into a receiving and discharging portion is more than usually complete. The true interventricular septum is much reduced in the craniocaudal direction and is smooth. The medial aspect of the ventricular walls below this are separate for the two ventricles and present columnae carneae. The infundibulum is smooth-walled and narrows rapidly into the pulmonary aorta.

Coronary vessels.—These are two in number, left and right. There is no separate atrial artery like that described in the elephant by the present author (Hill, 1936).

The left coronary, from the anterior aortic sinus, is a short, wide stem breaking up into a circumflex and an interventricular branch. The latter proceeds to the ventral interventricular cleft and at the top of the cleft immediately bifurcates into two vessels, one for each ventricle. They proceed toward the corresponding ventricular apex, the right one sending an arcade over the infundibulum. The circumflex branch proceeds to the left in the coronary sulcus onto the dorsal aspect; it just fails to gain the crux.

The right coronary artery takes the usual course, first between the aorta and the pulmonary stem, then around the right coronary sulcus to the crux. There it soon bifurcates to send two ventricular branches toward the apices on the dorsal aspect.

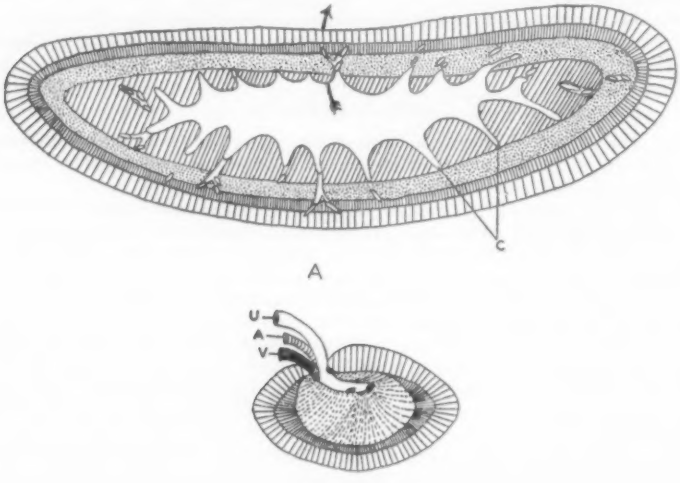

FIG. 4. Diagrammatic sections of dugong's kidney. A., coronal section; B., transverse section. Arrow in A indicates direction of ureteric outflow from pelvis of ureter.

In B. the kidney is shown with its dorsal aspect uppermost. A., renal artery; U., ureter; V., renal vein; C., calyces.

Of the veins, the bulk of the drainage is carried by the coronary sinus which receives the great cardiac vein from the left ventricle, two large trunks from the border of the interventricular cleft dorsally, and a large right cardiac vein from the right ventricle.

Systemic aorta.—The systemic arch is low and broad and set obliquely. The first part of the aorta is directed to the right as well as craniad; the second or transverse part takes a leftward and dorsalward course, and is the longest part. The third part has the ordinary relations. The first and major portion of the second parts are contained within the pericardium, whose visceral layer clothes the transverse part up to and including the roots of the branches arising from it. These are, on the part available, only two in number (1) an innominate, which bifurcates soon into right subclavian and right common carotid, and (2) a left common carotid. Owen figured the left subclavian arising at some considerable distance away, near the final bend of the arch, but this had not been retained on the hearts studied by me.

The concave aspect of the arch is connected by a thick, short fibrous cord, representing the ductus arteriosus, to the pulmonary trunk, just prior to the latter's bifurcation.

UROGENITAL SYSTEM

Kidneys.—The kidneys (fig. 4) are perhaps the least mammalian in appearance of all the viscera, with the possible exception of the lungs. Each is an elongated, fusiform gland with narrow, rounded poles thicker dorsoventrally than mediolaterally. Actual measurements are given in Table 1.

TABLE 1.—*Measurements of kidneys of dugongs*

	WEIGHT	CRANIOCAUDAL LENGTH	MEDIOLATERAL WIDTH	DORSOVENTRAL DEPTH
	grams	*mm*	*mm*	*mm*
Male.....left	264	170	46	50
right	294	183	46	50
Female.....left	450	215	66	40
right	420	215	66	39

They are surrounded by a fine, closely attached capsule. They show no superficial lobulation in contrast to those of the manatee and *Hydrodamalis* (*Rhytina*) (Steller, 1751), but structurally they are very complicated. The hilum is a restricted, oval opening placed about half way along the length of the organ and near the medial edge of its *dorsal* aspect. It receives the renal artery, with the renal vein lying ventrad thereto, and gives exit to the ureter, which lies behind the main artery but in front of one of its larger branches. Within the renal pelvis the relation changes slightly, the ureteric bifurcation lying ventrad to the main branches of the renal artery.

The kidney substance is composed of cortex and medulla arranged in pyramids; but the arrangement of the latter appears to be unique. In coronal sections of the kidney the pyramids appear to be arranged in pairs facing the renal pelvis, eight main pairs with some smaller intercalated ones and, in addition, two polar pyramids, one apical (or cranial) and one caudal. The arrangement in pairs is, however, merely an appearance seen in section. Actually the supposed pairs are joined across the ventral wall of the renal sinus by raised bars of renal tissue so that each pyramid forms, as it were, a girdle surrounding that cavity. This, with the elongation of the kidneys as a whole, is suggestive of a retained segmental structure.

Ureter.—The intrarenal portion is thin-walled, whereas the remainder forms a thick-walled cylindrical tube. Traced into the renal sinus, the ureter undergoes a bifurcation into two major calyces, cranial and caudal, of equal dimensions. These break up, opposite the corresponding pyramids, into the broad minor calyces, which receive about a dozen secretory ducts on the summit of the bars of renal tissue alluded to above.

The first portion of the extrarenal ureter has a transverse course of about one inch, thereafter undergoing a right-angled bend into the main part of the duct, which courses posteriorly behind the peritoneum towards the pelvis, where it is somewhat tortuous before opening into the dorsal aspect of the posterior part of the bladder very close to its fellow. In the female it has the usual relationship to the broad ligament.

Bladder and Urethra (fig. 6).—The bladder is relatively small for the size of the animal, but is provided with a very muscular wall. It is globular and only about one-third is related to the peritoneum. This differs in thickness, being thin over the fundus, but thick dorsally, where it forms part of the wall of the rectovesical pouch. The urachus is not recognizable, but on the ventral surface of the fundus, in both sexes, there is a thick-walled tube, 10 mm in diameter, ending blindly near the mid-line, but traceable laterally towards the pelvic parietes, whence it could not be traced further in the isolated visceral mass. This is the obliterated hypogastric artery occupying an unusual position, but agreeing most with the corresponding structure of the horse. Its conical blind medial termination and transverse disposition call for special remark.

The muscular coat fits over the bladder in a dome-shaped fashion, presenting a thick border just above the neck of the organ. The ureters gain entrance immediately beyond

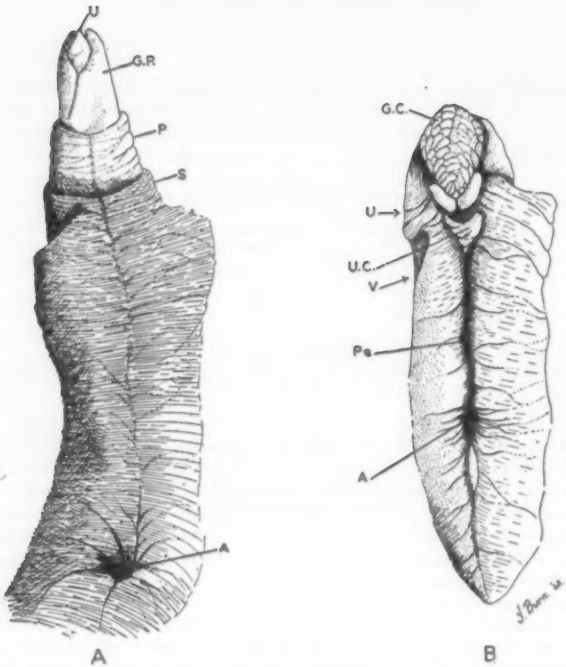

FIG. 5. External genitalia of dugong. A., male; B., female. A., anus; G.C., glans clitoridis; G.P., glans penis; P., preputium; Pe., perineal body; S., sheath of penis; U., position of urethral orifice; U.C., urethral caruncle; V., position of vaginal orifice.

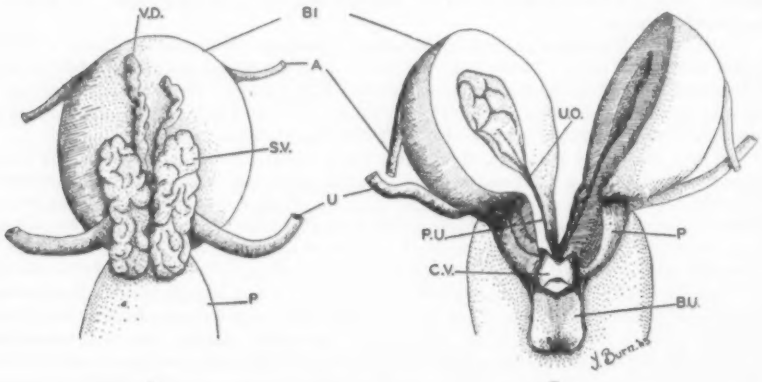

FIG. 6. Bladder and related parts of the male dugong. A., dorsal view; B., ventral view with bladder bisected in the median plane.

A., obliterated hypogastric artery; Bl., bladder; B.U., bulbar portion of urethra; C.V., cervix vesicae with opening from bladder into "prostatic" urethra; P., prostate-like body; P.U., prostatic urethra; S.V., seminal vesicle; U., ureter; U.O., ureteric orifice; V.D., vas deferens.

this free edge. Between them, in the male, lie the two seminal vesicles and the vasa deferentia, closely apposed to the bladder wall and covered dorsally by thick peritoneum.

The wall of the bladder is very thick, so that the cavity is relatively insignificant in dimensions. The mucous membrane is yellowish in color and thrown into longitudinal folds that converge toward the internal urinary meatus, except on the fundus, where the folds tend to run more transversely and to form a reticular pattern.

The ureteric openings are small and situated close together far back near the neck. There is thus no true trigone. The portion of the urinary tract that probably corresponds morphologically with the trigone of anthropotomy is produced to form a "prostatic" urethra. This extends for 25 mm from the level just caudad to the ureteric orifices. It is completely surrounded by a kind of prostate that is separated, by a constriction, from the neck of the bladder. In section there appears to be little or no glandular tissue, but the organ is composed of a thick mass of muscle ventrad to the urethra and of erectile tissue dorsally.

The most striking peculiarity of this region of the urinary tract, however, is the manner of termination of what has here been referred to as the "prostatic part of the urethra" in the succeeding or bulbar part of that passage. It is projected into the capacious bulbar urethra in telescopic fashion. The wall is thickened and protrudes caudally like a miniature cervix uteri. This "*cervix vesicae*", however, is more conical than a uterine cervix, but resembles the latter in having a transversely disposed *os*. The *os* is guarded by a thin ventral and a thicker, somewhat longer, dorsal lip. Fornices surround this prominence like those in the vagina. The common ejaculatory ducts embouch into the dorsal fornix by means of two slit-like orifices, separated by a very thin median septum situated on the dorsal aspect of the dorsal lip of the above described prominence. There is no utriculus masculinus (*sinus pocularis*), although Owen quotes Leuckart (1852) as maintaining that there is a large one.

The remainder of the urethra calls for little remark. There is no membranous portion. The bulbar part is greatly dilated but narrows down as it passes into the spongy part, which has the same relation to the corpus spongiosum as in Man. Its lumen is stellate in section. Cowper's glands appear to be lacking. It is clear that further detailed studies are warranted on the minute anatomy of the lower urinary tract.

The female urethra differs in being shorter. It is, however, surrounded by a prostate-like organ as in the male, but here the dorsal, erectile portion ensheathes the lower third of the vagina as well. The "prostatic" urethra of the female terminates in a cervix-like structure, but this is much smaller than in the male. This arrangement would appear to be a kind of valvular mechanism, although why an aquatic creature should need a valvular apparatus on the urinary passage is enigmatic.

Testes.—These organs were not found in the preliminary rough dissection and did not appear among the pelvic viscera removed for later study. It is therefore inferred that they lie either beneath the peritoneum of the pelvic or abdominal parietes, or between the layers of abdominal muscles, possibly in what corresponds to an inguinal canal. Owen's mention of them is very cursory and leads to the assumption that the Sirenia resemble whales in having the testes placed between the transversalis abdominis and the great depressor muscle of the tail.

Vasa deferentia.—Only the terminal portions of these are available. They are smaller, thinner walled, and more fragile than the ureters, which they cross from without inwards, thereafter passing medial to the seminal vesicles as in Man. This part of their course is well convoluted, the convolutions being bound together by firm fibrous tissue. Each joins the duct of the corresponding seminal vesicle to form a common ejaculatory duct which drains into the first part of the urethra.

Vesiculae seminales (fig. 6A).—These organs resemble those of man in size and shape, as well as in structure, but they are relatively smaller and lie somewhat closer together and more adpressed to the bladder wall. They are pale creamy-white in color, of firm consistency and thick-walled, with the cavities inside the lobules reduced to mere clefts. They measure 26.5 mm in height, 11 mm broad and 6 mm in dorsoventral depth. This is con-

siderably smaller than in Owen's half-grown male, so that probably a seasonal variation occurs. Their ducts unite with the vasa deferentia to form the two common ejaculatory ducts. These proceed through the dorsal spongy part of the prostate-like body to end in the bulbar urethra on the dorsal lip of the cervix vesicae.

Penis (fig. 5A).—Owen's description of the glans, with its two semilunar lateral lobes and the median conical eminence bearing the meatus urinarius on its summit, is correct. The glans extends proximally for 70 mm and is covered by smooth shiny mucous membrane. There is a short thick rudimentary *fraenum praeputii* on its ventral aspect.

The body of the penis is composed, like that of the human organ, of two large corpora cavernosa and a smaller corpus spongiosum. The latter carries the penile portion of the

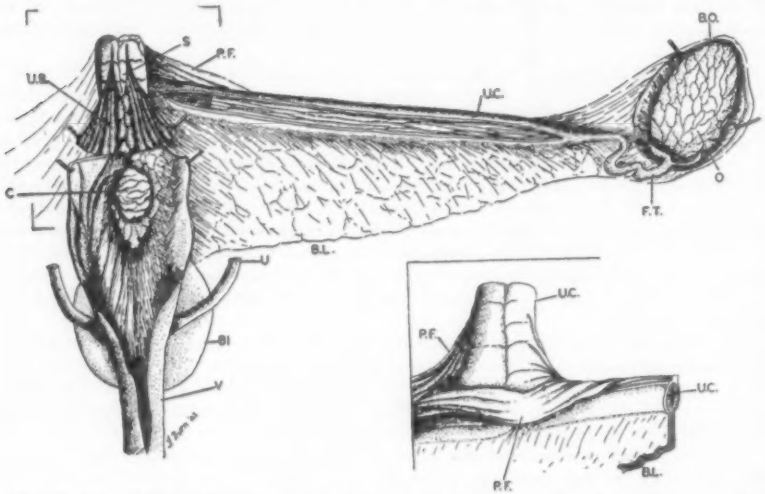

FIG. 7. Internal reproductive organs of the female dugong, viewed from the dorsal side; the vagina, uterine body and one cornu have been opened. Inset shows the portion marked off in the main figure drawn from the ventral aspect to show course of uterine cornua and their relation to the peritoneal folds. Bl., bladder; B.L., broad ligament; B.O., bursa ovarica; C., cervix; F.T., fallopian tube; O., ovary; P.F., peritoneal folds; S., septum; U., ureter; U.B., uterine body; U.C., uterine cornu; V., vagina.

urethra. It is enlarged posteriorly to form the bulb, which object is covered with a bulbocavernosus muscle. The corpora cavernosa are stronger and stouter than the corpus spongiosum. They possess a central pith formed of erectile tissue, surrounded by a very thick tunica albuginea. In the body of the organ they are separated by a complete septum, but they present a broad, shallow groove dorsally for the great dorsal vein and dorsalis penis nerves. Proximally the corpora diverge to form two crura, which are surrounded laterally and ventrally by thick muscles that may tentatively be referred to as *compressores crurium*. To exactly what part of the rudimentary pelvis these muscles, or the crura, are attached is at present not clear. They are distinct from the erector muscles, which are small fusiform bellies proceeding to the dorsum of each crus. The retractor muscles are large, fleshy muscles ending in a common median tendon that inserts on the fibrous tissue of the dorsum penis, as observed by Owen, who termed them levatores. There is no *os penis*.

Ovaries.—The ovaries are very large, softish organs of ovoid form. They measure 66 mm between their poles, 34 mm across and 17 mm thick. Each lies in a peritoneal ovarian pouch

which is itself hidden beneath the peritoneum of the dorsal abdominal wall below the kidneys and laterad to the ureters. It is connected to the wall of this pouch by a short thick mesovarial fold carrying the ovarian vessels. It is also connected to the diaphragm by a strong peritoneal fold. The surface is finely wrinkled but otherwise smooth.

Female genital passages (fig. 7).—The genital passages are supported by extensive ligamenta lata. They are divisible into tubes, uterine horns, uterine body, with cervix, and vagina. The arrangement of these is not nearly as simple as depicted in Owen's figure. The tubes are not contained within the broad ligament, there being no mesosalpinx. They commence each side in a small fimbriated, flattened funnel near the caudal pole of the ovary, embouching into the ovarian pouch. Proceeding thence beneath the peritoneum, forming a cord-like convoluted tube 42 mm long, they open into the apex of the corresponding uterine cornu at the point where the broad ligament arises from the pelvic parietes.

The uterine cornua are the longest parts of the tract, with the exception of the vagina. Each measures 167 mm long. They run horizontally and fairly straight for 115 mm of their length, which takes them almost to the midline, where, meeting its fellow and turning sharply dorsally and cranially, they parallel each other for 27 mm. Taking another sharp turn caudally, the cornua unite to form the uterine body, but internally a septum separates them for a distance of another 25 mm so that the fundus of the organ is internally double, although externally, to all appearances, single. A difference in the mucous lining occurs; that of the major part of each cornu being paler and more finely folded longitudinally, while that of the body and proximal parts of the cornua is greyish and more coarsely folded. The separation between these two zones is abrupt and occurs 25 mm before the first bend. Below the intra-uterine septum, the corpus uteri presents a median cavity with coarse longitudinal foldings, extending almost to the vaginal vault, a matter of 44 mm. It is succeeded by the cervix which proceeds caudally on the ventral aspect of the vaginal vault into which it is telescoped as in the human female. The cervical canal is a narrow passage with a continuation of the longitudinal rugae on its walls, but in the specimen examined it ended blindly below, there being no vestige of an opening into the vagina. The narrow canal is surrounded by thick fibro-muscular walls, and the absence of a communication with the vagina is probably to be explained on the grounds of immaturity (all the epiphyses were united in the bones of the pectoral limb). Canalization is probably delayed until puberty as in many monkeys.

The vagina is a long, relatively thin-walled tube, with a very capacious lumen, especially in its cranial two-thirds. Its lining mucosa is, for the most part, quite smooth, or with only very fine longitudinal foldings. True rugae, however, occur in the last third. The most striking feature in the vaginal interior is the arrangements in the vault. Extending from the summit of the vault, ventrally for almost half the length of the ventral wall, is a raised shield-shaped keratinized area, broad near the vault and narrowing to a point caudally. It is abruptly marked off from the rest of the vaginal mucosa. At about the middle of this shield-like area projects the vaginal portion of the cervix, which is covered by similar horny epithelium. Both the shield and the cervical prominence are marked by irregular sulci, and there is a well-marked sulcus surrounding the latter, demarcating it from the rest of the shield. One sulcus, deeper than the rest, runs transversely almost completely dividing the knob into cranial and caudal moieties. It is probably the precursor of an external os; but, as already noted, no perforation into the cervical canal could be detected. The ventral fornix, as a result of the above arrangement, is almost non-existent, but the lateral and dorsal fornices are capacious. The peritoneum of the pouch of Douglas just fails to reach the last-named fornix.

The last third of the vagina is embedded in fibro-erectile tissue derived from the prostate-like organ already described. This part of the prostate is more extensive than in the male. The lumen of the vagina is thereby considerably narrowed in this region. Near its orifice the vagina is surrounded by a well-developed sphincter muscle. The external openings in the vulva have already been considered above.

The vaginal lumen was distended with secretion of a mucous category, having a granular constitution when viewed microscopically.

Clitoris (fig. 5B).—The large glans has already been referred to. It is conical in form and its surface is wrinkled. There are some fissures, deeper than the rest, practically subdividing the substance of the glans into lobes. There is a very minute apical process almost spherical in form and completely surrounded by a deep fissure. Laterally, there are paired fissures separating two ovoid lobes that correspond, more or less, with the semilunar lobes of the penis, but they are flush with the general surface, and their covering is coarsened instead of having the smooth aspect of the penial processes (see fig. 5). On the other hand, these processes might conceivably be interpreted as remains of a praeputium, which, with the nymphae, is otherwise unrepresented. The corpus clitoridis divides proximally into two crura similar to the crura penis, but smaller. The compressor cruris muscle is present and relatively larger than on the penis. There is also an ischiocavernosus. The pars intermedia and the bulbar tissue are more fibrous than erectile in nature.

DUCTLESS GLANDS

Only the main points relating to the gross anatomy of the ductless glands are mentioned here, as it is proposed to deal with them more fully in a separate paper.

Thyroid.—There is a single median thyroid situated ventrad to the trachea (second and third rings) immediately posterior to the larynx. It resembles the human gland in consisting of an isthmus and two lateral lobes, but it is relatively stouter and more compact.

MEASUREMENTS OF THYROID GLAND

Maximum breadth	44 mm
Height	33 mm
Thickness through isthmus	10.5 mm
Weight	5.7 gm

The gland receives its blood supply mainly from the superior thyroid artery. No anastomotic channel between this and the inferior vessel was found; nor were any parathyroids observed macroscopically.

It has been suggested by Fawcett (1942), from work on the manatee, that the thyroid may be responsible in Sirenia for the peculiar structure of the bones, which he likens to "marble bone" disease in Man. The well developed state of the dugong's thyroid does not support this view.

Pituitary.—The pituitary gland is small and resembles that of the elephant in being completely uncovered dorsally by dura mater. Its stalk is short and the gland, in consequence, is closely applied to the base of the thalamencephalon, to which it is loosely attached by subarachnoid tissue. It is also slightly connected with the floor of the sella turcica. It weighs 0.3 gm and measures 12 mm anteroposteriorly, 11 mm transversely, and 6.5 mm dorsoventrally. Pars buccalis (anterior lobe) and pars nervosa are both well developed, the former embracing the latter on front and sides, giving rise to prominences in the latter position. The dugong's pituitary evidently resembles closely that of the manatee, according to Wislocki's (1940) account of the latter, who states that the pars tuberalis and pars intermedia are reduced.

Adrenals.—These lie near the cranial pole of the corresponding kidney, but not in contact therewith. They seem to present individual variations in form. The right gland in the male was a long tapering structure, that of the female a broad oval with a narrow, retroverted tail-like process at its lower pole. The left gland was more compact in both. Cortex and medulla are present, but the former presents unusual microscopic features.

Spleen.—The main spleen is small, but there is a tendency to the exhibition of spleniculi. One or two of these were situated at the hilum in the male, but the female had them more scattered. The main spleen lies upon, and is attached to, the great omentum near the left part of the greater gastric curvature. In the male it was only 98 mm long, 32 mm broad and 20 mm thick; an elongated ovoid in shape, it presented at its dorsal pole two constrictions, almost separating the gland tissue into two spleniculi. The hilum is on the medial side. The peritoneal covering and fibrous tunic are dense, but the pulp presents no unusual feature to the naked eye.

CENTRAL NERVOUS SYSTEM

Cranial cavity.—The dura mater is thick and vascular, for it possesses retia mirabilia as in ruminants. Falx cerebri and tentorium cerebelli are present, the latter not ossified.

Brain (fig. 8A, B, and C).—Apart from its firmness, the brain gives the general impression of a foetal brain, on account of (a) its thin covering of leptomeninges, with their fine, hair-like superficial cerebral veins and (b) the shallowness of their relatively few sulci.

Quite justifiably Elliot Smith (1892) remarked "Amongst the whole series of placental mammals there is no other animal in which the brain presents features so extraordinary and so bizarre as in the Sirenia. The only parallel which can be found for the peculiar cases presented by the manatee and the dugong is that occasionally presented in the brains of idiots, in which the process of elaboration has ceased in the earlier months of intrauterine life, and the organ has simply grown in size without becoming perfected in structure."

The brain of the manatee has been described by Murie (1872), Chapman (1875), Garrod (1877) and Beddard (1897); but that of the dugong only by Miklucho-Maclay (1881). The last-named contribution has not been available to me, so that I am unable to give a critical account of the organ. It manifestly deserves more detailed consideration than can be given here; only a brief general account is attempted here, and further consideration is deferred until Miklucho-Maclay's paper is available.

MEASUREMENTS OF THE BRAIN

Weight	265 gm
Maximum length	120 mm
Max. l. of hemisphere	88 mm
Max. cerebral breadth	93 mm (parietal)
Height of cerebrum	53 mm (frontal)
Breadth of cerebellum	58 mm

The cerebral hemispheres are more elongated than in the manatee. They are widely separated by a great longitudinal fissure. The two poles are rounded, the frontal being the smaller, although the frontal region measures more dorso-ventrally than the hinder parts. There is a shallow Sylvian fossa at the lower part of the lateral surface of each hemisphere. Here the insular cortex forms a broad bridge connecting the lower part of the frontal lobe with the temporal region. Above the fossa, but separated from it, a deep fissure depresses the whole thickness of the ventricular wall. It is deepest above, where it tends to fork. This is a pseudo-Sylvian sulcus. It separates the frontal lobe from the rest, which forms a practically undivided temporo-parieto-occipital lobe. Two horizontally disposed shallow sulci occur on the frontal lobe, one above, almost in line with the anterior bifurcation of the pseudo-Sylvian, and one on the orbital aspect, which is just visible in side view. A horizontal sulcus also occupies the parietal region and is in line with the posterior fork of the pseudo-Sylvian. It may be broken into two. A slight depression representing the parallel (superior temporal) sulcus lies behind the rounded temporal pole. A single horizontal sulcus occupies the medial surface of the hemisphere, and is interpreted by Elliot Smith as a combined calcarine and calloso-marginal. The ectorhinal is a mere notch on the medial edge of the basal aspect of the temporal pole. It permits the band of Giacomini to be seen without manipulation. A small, shallow sulcus also occurs on the basal surface near the temporal pole, but this is unconnected with the margins. The medial aspect of the temporal lobe behind the ectorhinal fissure is concave and permits the observation of the lateral geniculate body, with its brachium, and also the pulvinar, from below. These objects occupy a narrow interval between the concave edge of the hemisphere and the lateral surface of the crus cerebri.

The olfactory lobe and the stalk form a long cylindrical object lying well away from the great longitudinal fissure on the orbital aspect of the frontal lobe. They differ greatly from the same structures in the manatee. Posteriorly their roots are much obscured, especially by the aberrant location of the optic tract, which crosses almost transversely.

The corpus callosum is well developed, but shortened from before backwards. It ends anteriorly by joining the lamina terminalis at right angles. The latter structure is ver-

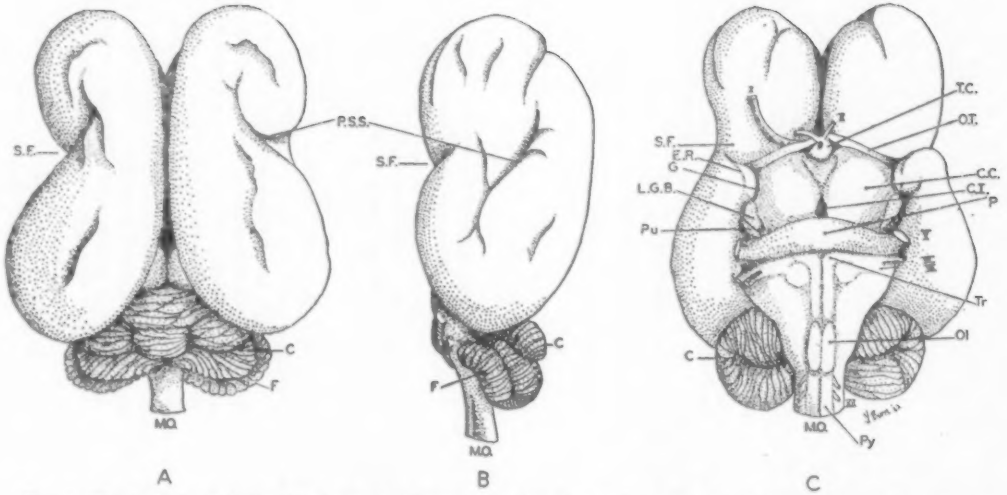

FIG. 8. Three views of the brain of a male dugong. A., dorsal view; B., left lateral view; C., ventral view. C., cerebellum; C.C., crus cerebri; C.I., corpus interpeduncular; E.R., ectorhinal fissure; F., floccular lobe; G., band of Giacomini; L.G.B., lateral geniculate body; M.O., medulla oblongata; Ol., olive; O.T., optic tract; P., pons; P.S.S., pseudo-Sylvian sulcus; Pu., pulvinar; Py., pyramid; S.F., Sylvian fossa; T.C., tuber cinereum; Tr., trapezium. (Cranial nerve roots are numbered in Roman numerals.)

tically disposed, ascending directly from the optic chiasma. It is extremely thin, especially at its junction with the corpus callosum.

The tuber cinereum is prominent, hollow, with a wide channel of communication with the pituitary stalk. It is greyish in color and lies immediately posterior to the chiasma. There are no corpora mammilaria, the tuber being succeeded by the interpeduncular fossa, in the rear part of which is a large interpeduncular body. The peduncles themselves are large and flattened, but, as already noted, do not prevent the lateral geniculate body and pulvinar from being seen. There is no pineal body, but a large habenular apparatus occurs.

In the mid-brain the corpora quadrigemina are well developed, the posterior pair being especially prominent, bulging backwards.

The pons is prominent, but narrow antero-posteriorly. Its lateral extremity is wholly occupied by the enormous roots of the trigeminal nerves. Behind the pons is a large trapezoid body, whose lateral extremities are similarly related to the roots of the facial and auditory nerves, the latter no doubt consisting chiefly of vestibular fibres. Pyramids are present, but are masked somewhat by the two olivary eminences, which lie superficial to them over part of their extent. The roots of the other cranial nerves call for no remark.

The cerebellum is very well developed, having, like the manatee, enormous flocculars lobes, consisting chiefly of paraflocculus. This is no doubt a development associated with the special postural balance required in an aquatic mammal and finds its parallel in the cetacean brain.

DISCUSSION

The sum total of the anatomy of the dugong, as revealed by the dissections recorded above, amply confirms the view that the Sirenia, as a group, show closer affinity with the ungulates than with any other mammalian order. Among these, they show likeness to the Proboscidea perhaps more than to any other ungulate group, chiefly because both retain generalized features (for example, bifid heart, certain features of the tongue; general form of thorax and relations of its contents; persistence of the left precaval vein), though some structures, such as the oesophagus and stomach and cranial retia mirabilia, foreshadow artiodactyl anatomy. Protagonists of cetacean connections for the Sirenia base their views mainly on the odontology of *Trichechus* (*Manatus*), which seems hardly sufficient to warrant such assumptions. Such other likenesses (whale-like tail) that exist can all be explained as adaptive features produced by parallel evolution in the two groups from the common adoption of a marine habitat. The status of the brain in the cetaceans, compared with its absurdly simple condition in the Sirenia, argues strongly against a close association.

Of the Sirenia, the dugong is usually regarded as being somewhat more specialized than the manatee (*cf.* Beddard, 1909), having lost all traces of nails, developed a whale-like tail and especially on odontological grounds. No new evidence arises from the present investigation in opposition to this view, except possibly that the dugong's brain is less distorted in shape than the manatee's; there is, on the other hand, scarcely anything further to support it, beyond perhaps the loss of the foetal lobulation of the kidneys. Notwithstanding, there is plenty of evidence of the primitive structure of the animal, indicative of an early branching off from the main stem that led to the ungulates (the condition of brain, kidneys, respiratory passages and the simple disposition of the peritoneum, besides those features which it shares with the elephant). There is also

evidence that the dugong has progressed for a long period along a side line of its own, as for example, the specialization in its uro-genital passages, the peculiar cardiac gland of the stomach and the pyloric caeca. All these are, however, most probably adaptive features correlated with the aberrant habitat and unusual diet.

CONCLUSIONS

In conclusion, I would again stress the superficial character of the present investigation, which does little more than raise a host of problems requiring further, more penetrating inquiry. That the animal is one of extreme scientific interest, both from the standpoint of the anatomist and of the general biologist, cannot be doubted; the sooner its full investigation is carried out the better, for the creature, already a rarity, will speedily succumb to the exploitation by local fishermen unless adequately protected by legislation.

Although original observations are incorporated throughout the foregoing account, the following special features that appear to be described for the first time warrant particular attention—(1) certain features of the tongue, stomach, anal canal, and pancreas, (2) additional facts relating to the heart and great vessels, (3) the structure of the kidneys and uro-genital passages and their adnexa in both sexes, (4) the anatomy of the ductless glands.

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A REVISED CLASSIFICATION OF THE AMERICAN ERMINES WITH DESCRIPTION OF A NEW SUBSPECIES FROM THE WESTERN GREAT LAKES REGION[1]

BY E. RAYMOND HALL

Study of American weasels, subgenus *Mustela*, indicates that there are in all four full species. *Mustela rixosa*, the least weasel, was studied by Swenk (Jour. Mamm., vol. 7, pp. 313–330, fig. 1, 1926) and subsequently was shown by Allen (Jour. Mamm., vol. 14, p. 316, 1933) to be a circumboreal species. A list of the long-tailed weasels, *Mustela frenata*, occurring in North and South America was published by Hall (Carnegie Inst. Washington, Publ. 473, pp. 90–114, fig. 101, 1936). The tropical weasel of the Amazonian Basin, *Mustela africana*, in 1939 was treated by the same author (Physis, tomo 16, pp. 159–178, 1 pl.). The study now reported upon reveals that the fourth and remaining group of weasels all pertain to a single species, *Mustela erminea*. This species, the ermine, like the least weasel, proves to be circumboreal in distribution.

The list of ermines presented below comprises, in so far as known to the writer, all the American subspecies that are recognizable on the basis of distinctive structural features. Names (synonyms) that have been proposed for American ermines now deemed indistinguishable from previously named kinds are set in italicized type immediately below the citation to the accepted name.

In this group of animals, which has a continuous distribution over approximately the northern two-thirds of North America, intergradation or lack of it is accepted as the criterion of subspecies and species, respectively. That is to say, if at a place where the ranges of two kinds meet, the populations freely interbreed in a state of nature, the two kinds are said to intergrade and accordingly are treated as subspecies of one species. If, on the contrary, the two kinds do not cross-breed at any place where their ranges meet or overlap, this constitutes lack of intergradation, and the two kinds, therefore, are treated as distinct species. Some qualification of the above statement is required in dealing with subspecies of *Mustela erminea* because several of them are insular races. In these insular kinds the degree of difference appears to be insufficient to prevent

[1] Assistance is acknowledged from the John Simon Guggenheim Memorial Foundation.

any one kind from intergrading with the kind on the next adjacent land mass if a land connection were established between the two. It is on this basis that the insular kinds listed below are included as subspecies of *Mustela erminea* instead of being arranged as separate species.

So far as known to me there remains only one heretofore unnamed American subspecies of *Mustela erminea* and it may be named and described as follows:

Mustela erminea bangsi new subspecies

Type.—Male, subadult, skull and skin; no. 11541, Donald R. Dickey Collection; Elk River, Sherburne County, Minnesota; November 1, 1925; obtained by Bernard Bailey, original no. A606.

Range.—Southern Manitoba, northeastern North Dakota, the whole of Minnesota, Wisconsin and Michigan, and northern Iowa.

Diagnosis.—Size: Large (see measurements). Color: Winter pelage all white except tip of tail which is always black. Summer pelage with upper parts uniform in color and darker (16*n*) than Raw Umber (capitalized color terms after Ridgway: Color Standards and Color Nomenclature, Washington, D. C., 1912); underparts Sulphur Yellow, Colonial Buff, or Primrose Yellow, often nearly white on chin and insides of forelegs; color of underparts extends narrowly over upper lips, distally on posterior sides of forelegs onto antipalmar faces of toes and sometimes over most of antipalmar surface of forefeet, on medial sides of hind legs to a point between knee and ankle but reappears on antiplantar faces of toes and in some individuals is narrowly continuous onto toes. Least width of color of underparts averaging, in males from Minnesota, 32(19–51) percent of greatest width of color of upper parts. Black tip of tail in 12 male topotypes in white winter pelage averaging 52(45–58) mm, which is 60(53–66) percent of length of tail-vertebrae. Skull: Large (see measurements), weight of cranium and lower jaws, 2.2 grams in adult male and 0.91 gram in adult female; breadth of rostrum measured across lacrimal processes less than a third of basilar length in males and rarely more (usually less) than length of tympanic bulla in females. In both sexes: Length of upper tooth-rows less than length of tympanic bulla; interorbital breadth less than distance between glenoid fossa and posterior border of external auditory meatus; zygomatic breadth less than distance between last upper molar and jugular foramen.

Comparisons.—From *Mustela erminea richardsonii*, selected differences of *bangsi* are: males smaller; in both sexes, least width of color of underparts averages about a third, instead of two-fifths, of greatest width of color of upper parts; skull of male lighter by a fifth or more, basilar length averaging less than 40 mm; cranial measurements average about 7(5–9) percent less in males in which the teeth are 10(9–11) percent shorter; in relation to basilar length, tympanic bullae longer in male *bangsi*. Skulls of females are individually indistinguishable, those of *bangsi* averaging about 1 percent less in linear measurements. From *Mustela erminea cicognanii* of the eastern United States, selected differences of *bangsi* are: both sexes larger, hind foot more than 40 mm in males and averaging 32 versus 30 mm in females; depth of skull at plane of molars 11.4 versus 10.0 in males and 9.1 versus 8.6 in females. In relation to the basilar length the preorbital region is smaller in males, whereas in females the bullae of *bangsi* are relatively longer and the skull is deeper. The skulls of females weigh about the same, but in males *bangsi* is a third heavier.

Remarks.—*Mustela erminea bangsi* heretofore has been referred to in the literature as *Mustela cicognanii*, although some zoologists (for instance Hamilton, Amer. Midl. Nat., vol. 14, p. 295, 1933) have suggested that the larger size, as indicated by weights, might justify separate subspecific status for the animal of Minnesota.

From the range of *M. e. invicta* in the Rocky Mountains, that of *bangsi* is separated by the Great Plains from most of which region the species *Mustela erminea* is unknown. *M. e. bangsi* differs from *invicta* in greater degree of sexual dimorphism in size, and in each sex by larger size, narrower light-colored underparts, and deeper brain case as measured at the

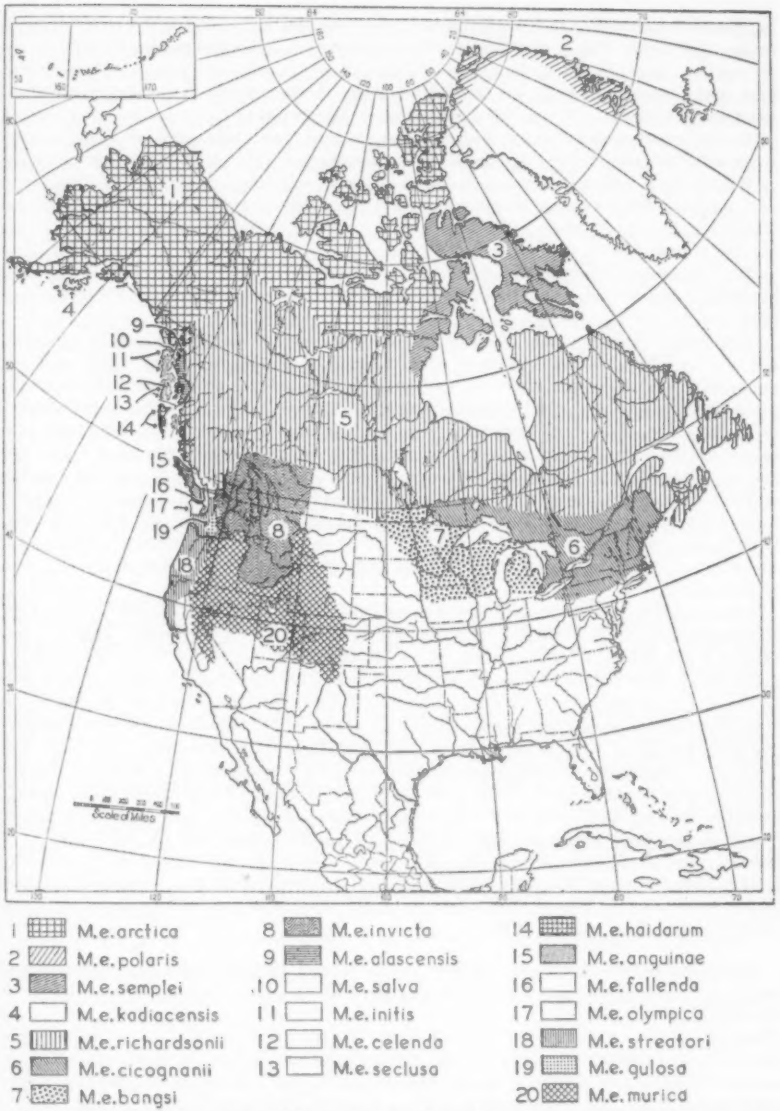

FIG. 1. Map showing geographic ranges of subspecies of *Mustela erminea* in America.

anterior margin of the basioccipital. In *bangsi* the brain case is deeper in relation to the length of the skull.

Of the two subspecies whose ranges do meet that of *bangsi*, it more closely resembles *richardsonii* than *cicognanii*. From *richardsonii*, particularly from the southeastern popu-

lations of the same in which the skull is of the same size as in *bangsi*, the latter differs in longer hind feet. This is an average difference and by one interpretation the animals here referred to *bangsi* might be lumped with some of the populations from the southeastern part of the range of *richardsonii* and the whole lot treated as intergrades between *richardsonii* and *cicognanii*. Nevertheless, the animals here referred to *bangsi* are not geographically intermediate between *richardsonii* and *cicognanii* and this consideration has much to do with the decision to recognize as a separate subspecies the animals here named *bangsi*.

Within the range of the subspecies there is some geographic variation; the hind feet of animals from Iowa average slightly shorter than those of animals from Minnesota and Wisconsin, but are nowhere nearly as short as in *cicognanii* at the same latitude in the eastern United States.

It is noteworthy that the few specimens seen from Isle Royal have the long hind feet of *bangsi* and not the short hind feet of *cicognanii*, which occurs all along the northern mainland.

I am sympathetic with the rule that the personal names of men should not be applied to animals both because the expression thus of personal sentiments often degenerates into apparent adulation of the powerful, and because the person so 'honored' may prefer his name preserved to posterity by the medium of his sons rather than also by one of nature's other creatures, say, a louse, or even a weasel. The rule is broken by proposing the name *bangsi* for the subspecies of weasel under consideration but Outram Bangs, the man concerned, left no sons and is himself deceased. These circumstances would seem to preclude either displeasure on his part or reward to me. Also he wrote the best paper yet to appear on American weasels (A Review of the Weasels of Eastern North America, Proc. Biol. Soc. Washington, vol. 10, pp. 1–24, February 25, 1896) and it is in recognition of Mr. Bangs' superior work on the genus *Mustela* that his name is proposed for an American subspecies of that genus.

Measurements.—Average and extreme measurements of 5 adult males from Aitkin, Minnesota, and 5 adult females from central Minnesota, are: Total length, ♂♂ 321(291–341), ♀♀ 249(240–260); length of tail, 90(76–101), 61(55–65); length of hind foot, 43(40–44), 32(30–33); basilar length of Hensel, 39.7(38.5–40.7), 32.8(31.8–33.6); length of tooth rows (along median longitudinal axis of skull from anterior faces of incisors to a line connecting posterior margins of molars), 14.0(13.4–15.0), 11.1(10.8–11.6); breadth of rostrum measured across lacrimals, 12.0(11.2–12.7), 9.5(9.0–9.9); least interorbital constriction, 9.7(9.0–10.6), 7.7(7.4–8.1); orbitonasal length (diagonally from posteriormost margin of anterior nares to posterior side of postorbital process near its tip), 13.8(12.6–14.6), 11.3(10.9–12.2); mastoid breadth, 19.8(18.8–20.6), 17.6(16.8–18.4); zygomatic breadth 22.7(21.0–24.3), 17.6(16.8–18.4); length of tympanic bulla, 14.3(13.7–14.6), 12.0(11.7–12.3); length of M_1, 5.1(4.9–5.3), 4.0 (3.8–4.2); length of lateral side of P^4, 4.6(4.4–4.6), 3.7(3.6–3.8); breadth of M^1, 3.6(3.4–3.8), 2.9(2.8–3.0); length of M^1, 2.0(1.8–2.6), 1.6(1.4–1.7); depth of skull at anterior margin of basioccipital, 13.0(12.0–13.5), 10.4(9.6–11.2); depth of skull at posterior border of basioccipital, 11.5(10.5–12.2), 8.8(8.3–9.3).

Specimens examined.—Total number, 222, arranged alphabetically by provinces and states and, arranged from north to south, by counties in each state. Unless otherwise indicated, specimens are in the University of Wisconsin Museum of Zoology. The word *County* is written out in full for localities when the name of the county was recorded on the label attached to each specimen. If the name of the county was omitted on the label of even one specimen from a given county, the abbreviation *Co.* is here used. **Iowa.** *Dickinson County:* W side Lake Okobogie, 1^1. *Winnebago County:* Lake Mills, 7^2. *Worth County:* Northwood, 1^2. *Clay County:* "Dewey's Pasture, near Ruthven," 1^3. **Manitoba.** Aweme, 4^4; Red River Settlement, 1^5. **Michigan.** *Isle Royal:* Tobin Harbor, 1^2; Bell Isle, 1^2; Washington Harbor, 3^2. *Ontonagon Co.:* Ontonagon, 2 (1^2, 1^6); T.51N, R.43W, s17, Porcupine Mts., 1^2. *Gogebic County:* Little Girls Point, 5^2; Ironwood, 1^2. *Iron County:* no locality more definite than county, 1^2. *Luce Co.:* Taquahmenaw River Falls, 1^5. *Chip-*

pewa Co.: Sault Ste. Marie, 2^3. *Emmet County:* Wilderness State Park, 2^3. *Cheboygan County:* Univ. Mich. Biol. Station, 1^3. *Washtenaw Co.*: Ann Arbor, 1^3. **Minnesota.** *Kittson County:* no locality more definite than county, 1^5. *Roseau County:* Deer Township, 1^5; Falun Township, 2^3. *Marshall Co.*?: Moose River, 5^3; Warren, definitely in Marshall County, 1^3. *Cook County:* Grand Maris, 3 (2^3; 1^6). *St. Louis County:* 2 mi. E. Babbit, 14^3; Burntside [= Burnside] Lake, 1^5. *Itasca County:* T.61N, R.26W, 23. *Clay Co.*: Moorhead, 3^{10}. *Aitkin Co.*: Aitkin, 13 (11^{11}, 1^{12}, 1^{13}). *Otter Tail Co.*: Arthur, 3^{11}; Ten Mile Lake, 1^3; Parkers Prairie, 2^{14}. *Chisago Co.*: North Branch, 1^{11}. *Sherburne Co.*: Elk River, 42 (16^5, 5^6, 20^7, 1^{15}). *Hennipen Co.*: Lake Minnetonka, 1^{14}; Minneapolis, 1^5; Fort Snelling, 5 (4^3, 1^{11}). **North Dakota.** *Pembia Co.*: Walhalla, 1^5. *Nelson Co.*: Stump Lake, 1^5. *Eddy Co.*: Brantford, 2^3. **Wisconsin.** *Douglas County:* T.44N, R.13W, 1; Gordon, 1. *Bayfield Co.*: Brinks Camp, Washburn, 1^5; "near Cable," 1. *Ashland County:* Bear Lake, 2. *Iron County:* Fisher Lake, 4; Mercer, 5. *Vilas Co.*: Mamie Lake, 16^5; Ox Bow Lake, 1^5. *Oneida Co.*: Tomahawk Lake, 1^{11}. *Langlade County:* T.34N, R.11E, 3. *Rush Co.*: Ladysmith, 1. *Dunn County:* Colfax, 2. *Door County:* Mink River, Ellison Bay, 1^3. *Dodge Co.*: Fox Lake, 1^{16}; Beaver Dam, 12^{16}.

[1] Coll. T. C. Stephens. [2] Iowa State College. [3] Museum of Zoology, University of Michigan. [4] Coll. Stuart Criddle. [5] United States National Museum. [6] Coll. Alex Walker. [7] Coll. D. R. Dickey. [8] American Museum of Natural History. [9] University of Kansas Museum of Natural History. [10] Carnegie Museum. [11] Field Museum of Natural History. [12] British Museum of Natural History. [13] Berlin Zoological Museum. [14] Museum of Comparative Zoology. [15] Museum of Vertebrate Zoology. [16] Coll. W. E. Snyder.

AMERICAN SUBSPECIES OF MUSTELA ERMINEA

1. **Mustela erminea arctica** (Merriam).

1896. *Putorius arcticus* Merriam, N. Amer. Fauna, no. 11, p. 15. June 30, 1896.

1904. *Putorius audax* Barrett-Hamilton, Ann. and Mag. Nat. Hist., ser. 7, vol. 13, p. 392. May 1904. Type from Discovery Bay, Ellesmere Island (not Greenland).

Type Locality.—Point Barrow, Alaska.

Range.—Arctic regions of America from the Pacific Ocean east to Smith Sound; from the northern limit of land south approximately to a line from Skagway through Ft. Goodhope, north shore of Great Bear Lake, south shore of Clinton Colden Lake, north shore of Baker Lake, west end of Wagner Bay to south end of Committee Bay.

2. **Mustela erminea polaris** (Barrett-Hamilton).

1904. *Putorius arcticus polaris* Barrett-Hamilton, Ann. and Mag. Nat. Hist., ser. 7, vol. 13, p. 393. May 1904.

Type Locality.—Gap Valley, 7½ miles northeast Cape Brevoort, 82°N, 59°20′W, northwestern Greenland.

Range.—North coast, and east coast as far south as Turner Sound, of Greenland.

3. **Mustela erminea semplei** Sutton and Hamilton.

1932. *Mustela arctica semplei* Sutton and Hamilton, Ann. Carnegie Mus., vol. 21, no. 2, p. 79. February 13, 1932.

1935. *Mustela arctica labiata* Degerbøl, Rept. 5th Thule Exped., 1921–1924, vol. 2, no. 4, p. 25, 1935. Type from Malugsitaq, Melville Peninsula, Canada.

Type Locality.—Coral Inlet, South Bay, Southampton Island, Canada.

Range.—Baffin and Southampton islands, Melville Peninsula and west side of Hudsons Bay as far south as Eskimo Point.

4. **Mustela erminea kadiacensis** (Merriam).

1896. [*Putorius arcticus*] *kadiacensis* Merriam, N. Amer. Fauna, no. 11, p. 16. June 30, 1896.

Type Locality.—Kodiak Island, Alaska.
Range.—Kodiak Island.

5. **Mustela erminea richardsonii** Bonaparte.
1838. *Mustela Richardsonii* Bonaparte, Charlesworth's Mag. Nat. Hist., vol. 2, p. 38. January 1838.
1903. *Putorius microtis* Allen, Bull. Amer. Mus. Nat. Hist., vol. 19, p. 563. October 10, 1903. Type from Shesley, British Columbia.
1904. *Putorius arcticus imperii* Barrett-Hamilton, Ann. and Mag. Nat. Hist., ser. 7, vol. 13, p. 392. May 1904. Type from Fort Simpson, Mackenzie, Canada.
Type Locality.—Probably Fort Franklin, Canada.
Range.—Hudsonian and Canadian life-zones of the greater part of Canada from the Atlantic to the Pacific.

6. **Mustela erminea cicognanii** Bonaparte.
1838. *Mustela cigognanii* Bonaparte, Charlesworth's Mag. Nat. Hist., vol. 2, p. 37. January 1838.
1842. *Mustela pusilla* DeKay, Nat. Hist. of New York, Zool., pt. 1, Mammalia, p. 34. 1842. Type from state of New York.
Type Locality.—Eastern United States.
Range.—Transition and higher life-zones of northeastern United States south to Connecticut, central Pennsylvania and extreme northeastern Ohio; in Quebec and Ontario westward from the latitude of central Maine to Lake Nipigon and Lake of the Woods.

7. **Mustela erminea bangsi** Hall.
1945. *Mustela erminea bangsi* Hall, present paper, p. 176.
Type Locality.—Elk River, Sherburne County, Minnesota.
Range.—Southern Manitoba, northeastern North Dakota, the whole of Minnesota, Wisconsin and Michigan, and northern Iowa.

8. **Mustela erminea invicta** Hall.
1945. *Mustela erminea invicta* Hall, Jour. Mamm., vol. 26, p. 75. February 23, 1945.
Type Locality.—Benewah, Benewah County, Idaho.
Range.—Central Rocky Mountain region from Jasper Park south over Alberta, southeastern British Columbia, Washington east of the Cascades, north and central Idaho and northwestern Montana.

9. **Mustela erminea alascensis** (Merriam).
1896. *Putorius richardsonii alascensis* Merriam, N. Amer. Fauna, no. 11, p. 12. June 30, 1896.
Type Locality.—Juneau, Alaska.
Range.—Mainland of southeastern Alaska south to include Mitkof, Wrangel and Revillagigedo islands.

10. **Mustela erminea salva** Hall.
1944. *Mustela erminea salva* Hall, Proc. Biol. Soc. Washington, vol. 57, p. 35. June 28, 1944.
Type Locality.—Mole Harbor, Admiralty Island, Alaska.
Range.—Admiralty Island, Alaska.

11. **Mustela erminea initis** Hall.
1944. *Mustela erminea initis* Hall, Proc. Biol. Soc. Washington, vol. 57, p. 37. June 28, 1944.

Type Locality.—Saook Bay, Baranof Island, Alaska.
Range.—Chichagof and Baranof islands, Alaska.

12. **Mustela erminea celenda** Hall.
1944. *Mustela erminea celenda* Hall, Proc. Biol. Soc. Washington, vol. 57, p. 38. June 28, 1944.
Type Locality.—Kasaan Bay, Prince of Wales Island, Alaska.
Range.—Prince of Wales, Dall and Long islands, Alaska.

13. **Mustela erminea seclusa** Hall.
1944. *Mustela erminea seclusa* Hall, Proc. Biol. Soc. Washington, vol. 57, p. 39. June 28, 1944.
Type Locality.—Santa Cruz, Suemez Island, Alaska.
Range.—Known only from the type locality.

14. **Mustela erminea haidarum** (Preble).
1898. *Putorius haidarum* Preble, Proc. Biol. Soc. Washington, vol. 12, p. 169. August 10, 1898.
Type Locality.—Massett, Graham Island, Queen Charlotte Islands, British Columbia.
Range.—Queen Charlotte Islands.

15. **Mustela erminea anguinae** Hall.
1932. *Mustela cicognanii anguinae* Hall, Univ. California Publ. Zool., vol. 38, p. 417. November 8, 1932.
Type Locality.—French Creek, Vancouver Island, British Columbia.
Range.—Vancouver Island, British Columbia.

16. **Mustela erminea fallenda** Hall.
1945. *Mustela erminea fallenda* Hall, Jour. Mamm., vol. 26, p. 79. February 23, 1945.
Type Locality.—Huntingdon, British Columbia.
Range.—On mainland in immediate vicinity of coast from probably opposite Texada Island, British Columbia, south to Lake Whatcom, Washington, and east to Mount Baker Range on International Boundary.

17. **Mustela erminea olympica** Hall.
1945. *Mustela erminea olympica* Hall, Jour. Mamm., vol. 26, p. 81. February 23, 1945.
Type Locality.—Near head of Soleduck River, 4500 ft., Olympic Mountains, Clallam County, Washington.
Range.—Olympic Peninsula, Washington, south to Olympia.

18. **Mustela erminea streatori** (Merriam).
1896. *Putorius streatori* Merram,N.Amer. Fauna, no. 11, p. 13. June 30, 1896.
Type Locality.—Mount Vernon, Skagit Valley, Skagit County, Washington.
Range.—Western Washington along eastern side of Puget Sound, western Oregon from the Cascades to the Coast, and northwestern California south in the humid coastal district nearly to the Golden Gate.

19. **Mustela erminea gulosa** Hall.
1945. *Mustela erminea gulosa* Hall, Jour. Mamm., vol. 26, p. 84. February 23, 1945.
Type Locality.—Trout Lake, Klickitat County, Washington.
Range.—Cascades from northeastern King County south to Mount Adams.

20. **Mustela erminea murica** (Bangs).
1899. *Putorius* (*Arctogale*) *muricus* Bangs, Proc. New England Zool. Club, vol. 1, p. 71. July 31, 1899.

1903. *Putorius streatori leptus* Merriam, Proc. Biol. Soc. Washington, vol. 16, p. 76. May 29, 1903. Type from Silverton, San Juan County, Colorado.

Type Locality.—Echo, 7500 ft., El Dorado County, California.

Range.—Principally boreal life-zones from central and southwestern Montana, southern Idaho, and Blue Mountains of southeastern Washington southward east of the Cascade Divide through the Salmon River Mountains and Sierra Nevada at least into Fresno County of California, in the Great Basin to central Nevada, and in the Rocky Mountains into northern New Mexico.

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QUATERNARY RODENTS AND LAGOMORPHS OF SAN JOSECITO CAVE, NUEVO LEON, MEXICO

By J. E. Cushing, Jr.

This paper is a report on the rodents and lagomorphs found in the deposits of San Josecito Cave, near the town of Aramberri, southern Nuevo Leon, Mexico. The cave is approximately 7,400 feet above sea-level in mountainous country that, in this vicinity, supports a forest cover of pine and oak. The inhabitants of the region long believed that the cave contained buried treasure and in searching for this disturbed the floor to a depth of several feet. Subsequent operations by workers from the California Institute of Technology extended the diggings some sixty or seventy feet, which evidentally is near the bottom of the fossiliferous deposit. The cave accumulation includes a wealth of ossiferous material, the remains of thousands of individuals that either fell or were carried into the cave in late Pleistocene time. The fauna includes antelope (*Stockoceros conklingi*), deer, large ovibovid (*Preptoceras*), horse (*Equus*), ground sloth (*Nothrotherium*), sabre tooth cat (*Smilodon*), dire wolf (*Aenocyon*) and a vampire bat. Some of these forms are well represented. There is likewise a large variety of smaller mammals and birds (Miller, 1943).

REVIEW OF THE RODENTS AND LAGOMORPHS

Following is a list of the rodents and lagomorphs occurring in the Quaternary deposits of San Josecito Cave:

Marmota (marmot)
Citellus (ground squirrel)
Sciurus (tree squirrel)
Thomomys (pocket gopher)
2 unidentified geomyids
Liomys (pocket mouse)
Reithrodontomys (harvest mouse)
Peromyscus (white-footed mouse)
Sigmodon (cotton rat)
Neotoma (wood rat)
Synaptomys cooperi (lemming mouse)
Microtus (meadow mouse)
Sylvilagus leonensis, n. sp. (dwarf rabbit)
Sylvilagus sp.? (cottontail rabbit)

The remains of some individual kinds of rodents in the cave are present in large numbers. This abundance seems to have resulted mostly from the work of raptorial birds that inhabited the area. Because only a few specimens of small Recent mammals for comparative use in identifying species are available from

the San Josecito area, no attempt is now made to determine more than the generic identity of most of the species.

Rabbits are well represented, the bones of several hundred individuals having been collected. These belong to two species of *Sylvilagus*. One, by far the most abundant, is referable to the cottontail group. The other is a pigmy form with size comparable to that of the living pigmy rabbit (*Sylvilagus idahoensis*). Nevertheless, the Mexican leporid from San Josecito Cave is not as closely related to *S. idahoensis* or the rarer *Romerolagus diazi* of Mexico (both apparently relics with restricted ranges that do not include the cave area) as to the cottontails. However, it is much smaller than any known cottontail or brush rabbit and apparently represents a new species.

TABLE 1.—*Comparative measurements (in millimeters)*

	WIDTH ACROSS INCISIVE FORAMINA	LENGTH OF LEFT UPPER CHEEK-TOOTH SERIES	WIDTH OF PALATE	WIDTH OF CHOANAE
Sylvilagus leonensis C.I.T. Vert. Paleo. No. 3212	4.7	10.1	6.2	3.4
C.I.T. Vert. Paleo. No. 3211	4.5	10.1	5.5	3.6
C.I.T. Vert. Paleo. No. 3209	4.9	9.6	5.2	3.5
C.I.T. Vert. Paleo. No. 3210	4.4	9.2	4.7	3.9
C.I.T. Vert. Paleo. No. 3213	5.5	10.1	5.4	—
Sylvilagus idahoensis Dickey collection. No. 17274, ♀	6.4	9.1	3.8	4.6
Dickey collection No. $\frac{9061}{2910}$, ♂	6.5	8.8	3.4	4.7
M.V.Z. No. 36361, ♀	5.8	9.0	3.9	4.0
M.V.Z. No. 36362, ♂	6.4	9.0	3.7	4.1

Sylvilagus leonensis, n. sp.

Type specimen.—Complete left ramus, no. 3208, California Institute of Technology, Vert. Paleo. Coll.

Co-type.—Palatal portion of skull, no. 3209, C.I.T. Vert. Paleo. Coll., lacking M^1 and M^3 of the left side, and P^2 and M^3 of the right.

Additional Material.—25 right rami and 33 left rami, 5 entire palates and portions of 13 others; 5 adult humeri, 2 femora, 3 ulnae, and one radius.

Locality.—Calif. Inst. Tech. Vert. Paleo. Loc. 192, San Josecito Cave Pleistocene, southern Nuevo Leon, Mexico.

Diagnosis.—Referable to subfamily Leporinae (Dice, 1929) on basis of enamel folding of PM_3; and to the genus *Sylvilagus* on basis of enamel pattern of molariform teeth, small size, and the relatively long palate as compared to the width of choanae and incisive foramina (Lyon, 1903). The cave rabbit can be readily distinguished from all known species of *Sylvilagus* except *idahoensis* by its smaller size, and from the latter species by the following characters: (1) much wider palate, which exceeds width of choanae (see Table 1 for comparative measurements); (2) external re-entrant angle of upper molariform teeth crenulate, par-

ticularly on anterior edge; (3) PM_3 with broad shallow re-entrant angle (none in *idahoensis*); (4) posterior portion of lower molariform teeth, except M_3, relatively wider in relation to anterior portion than in *idahoensis*.

Discussion of characters.—Comparison of the material listed shows that the diagnostic characters given above are constant insofar as these can be determined, with one partial exception. The anterior re-entrant angle in PM_3, although always present, is variable in degree of expression and is crenulate in one of the eighteen teeth examined. This specimen is exceptional, but its peculiarity may be due to extreme wear.

The large number of rabbits occurring in the deposits gives added significance to the fact that no bones referable to the hares (genus *Lepus*) have been found. If a moderate or large population of hares existed near the cave during the time of accumulation of the deposits, the population probably would have been sampled by the larger birds of prey that were then prevalent. Hares occur, at least in the general region, about the cave at present (Nelson, 1909).

RODENT ASSEMBLAGE

Another animal whose range definitely has changed is the marmot (*Marmota* sp.), represented, however, by the rami of only two left lower jaws. Unfortunately these do not suffice to tell which of the three modern species was present, a fact that would be of interest, for these species occupy different habitats today. However, no living marmots of any kind now range into Mexico. The closest approach is made by colonies of the yellow-bellied marmot (*Marmota flaviventer obscura*) that inhabit the mountains of northern New Mexico (Howell, 1915). Further evidence that the range of the genus has changed within Recent times is found in the presence of skeletal remains of the species *flaviventer* in the New Mexican mountains somewhat to the south of the present colonies (Howell, *op. cit.*, p. 55), yet still north of the Mexican boundary.

One other species that has changed its range since entombment in the cave deposits is the lemming mouse (*Synaptomys cooperi* subsp. ?), of which several mandibles were taken from the surface layers of the cave. This is the only instance where a form obtained in the disturbed surface layers of the cave has not been found subsequently at greater depths. According to Howell (1937) lemming mice live as far south as Arkansas in the Upper Austral Life-zone along the eastern border of the Great Plains. On the Atlantic slope they range southward into North Carolina. Howell reports that at these extreme southerly localities *Synaptomys cooperi* lives mostly in cold sphagnum bogs, although it has been trapped in moist and dry grass lands. In the state of New York these mice have been found to live in heavily forested areas and appear to be colonial in habit (Hamilton, 1941, p. 195). Apparently *cooperi* does not require a particularly cold climate. Such a view is in agreement with the conditions suggested by the remainder of the Pleistocene fauna recorded from San Josecito Cave. The one additional microtine rodent in the collection belongs to the genus *Microtus*; the remains of this meadow mouse far outnumber those of the lemming mouse.

At least three kinds of gophers are found in the cave deposits. The most abundant form is *Thomomys*. A few cranial and limb bones indicate the presence of two larger forms. Unfortunately material of the latter is too fragmentary to permit generic identification.

Sciurus and *Citellus* have been identified on the basis of a skull and three mandibles. The ground squirrel is represented by rami of lower jaws comparable in size to that of *Ammospermophilus*.

Aside from a single mandible of an immature porcupine (*Erethizon ?*) and skulls of many spiny pocket mice (*Liomys*), the remainder of the rodent remains consists of jaws and skeletal parts of several hundred cotton rats (*Sigmodon*), wood rats (*Neotoma*), harvest mice (*Reithrodontomys*) and white-footed mice (*Peromyscus*), all cricetine rodents.

Unfortunately, the San Josecito rodent fauna is not particularly indicative of the past climate of the region, although it suggests that the conditions in which it lived were similar to those encountered in the area today. Irrespective of the extent to which the climate of the country may have changed, the excavations already show a considerable faunistic difference between the time of the Pleistocene animals and that of the present.

The deposit was called to the attention of the California Institute of Technology by J. W. Patterson and has been extensively excavated under the direction of Dr. Chester Stock. It was at the suggestion of Dr. Stock and under his guidance that the present study was carried out. I should like to thank persons in charge of the Donald R. Dickey Collection, the U. S. National Museum, the California Academy of Sciences, and the Museum of Vertebrate Zoology, University of California, for advice and for the loan of several specimens.

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CRICETINE RODENTS OF THE MIDDLE PLIOCENE OF THE MULHOLLAND FAUNA, CALIFORNIA

By Donald F. Hoffmeister

Cricetine rodents from the Middle Pliocene of North America have been recorded from the Edson beds of Kansas, the Thousand Creek and Smith Valley beds of Nevada, and the Kern River beds of California. Each of the cricetines in these deposits, except one of doubtful generic status, has been referred to the genus *Peromyscus*. Recently, remains of cricetines have been recovered from the quarries of the Mulholland Fauna of the San Francisco Bay region, California, which deposits were judged by Stirton (1939, p. 366) to be of early Middle Pliocene age. These fossils not only indicate another record of the genus *Peromyscus* in the Middle Pliocene of North America but more interestingly provide evidence of a new genus which superficially appears to be intermediate between the wood rats and Nearctic mice of the subfamily Cricetinae, and which genus, in certain respects, parallels structurally the Recent genus *Neotomodon* of Mexico.

Associated with the cricetines in the quarry, of the Mulholland Fauna, designated as site 2 are the following mammalian remains, as reported by Stirton (*op. cit.*): a rabbit (probably of the genus *Hypolagus*), a ground sloth (Megalonychidae), a canid, a rhinoceros (possibly *Teleoceras fossiger*), two kinds of horses (*Nannippus* and *Pliohippus* cf. *spectans*) and two kinds of camels. The only mammalian fossil from the quarry designated as site 1, in addition to one specimen of a cricetine, is an antilocaprid (Stirton, *op. cit.*, p. 385).

Through the kindness of Dr. R. A. Stirton the specimens herein reported were placed at my disposal when I made a study of the phylogenetic relationships of the Nearctic cricetine rodents. Mr. Owen Poe prepared the drawings of *Pliotomodon* and Mrs. Emily Thompson prepared those of *Neotomodon*.

Pliotomodon primitivus, new genus and species

Type.—No. 36030, Univ. Calif. Mus. Paleo.; part of left maxilla bearing M^{1-3}; from Middle Pliocene deposits of site 2 (see below) of the Mulholland Fauna, California; obtained in 1938.

Type locality.—Mulholland site 2, Univ. Calif. Paleo. Loc. no. V-3611; 1½ mi. N and ½ mi. E Moraga, Contra Costa County, California; in quarry on southwest-facing slope in blue and gray ferruginous, sandy clays below a bed of conglomerate; originally called Orinda Formation, now referred to as part of the Tassajero Formation. See Stirton (1939, fig. 93) for map showing the location.

Paratypes.—All in Univ. Calif. Mus. Paleo. From type locality: No. 37632, part of right maxilla bearing much worn M^1 and anterior part of M^2; no. 37633, part of right maxilla bearing M^{1-2} (anterocone of M^1 broken away), with "medium" amount of wear, but slightly more than in type; no. 37534, isolated right M_2, with medium wear. From Mulholland site 1, in nearly vertical beds of greenish sandstone and clays, ¾ mi. N and 1½ mi. E Moraga, Univ. Calif. Paleo. Loc. no. V-3303, Contra Costa County, California, no. 37535, left M_{1-3} (slightly worn and with parts of M_1 and M_3 broken away), with small amount of attached mandible.

Diagnosis.—Medium-sized cricetines with hypsodont teeth; molariform teeth and cusps narrowed transversely and lengthened anteroposteriorly; anterocone, paracone, and metacone connected along labial side of upper teeth, but in lower teeth connection only between anteroconid and metaconid of M_1 and between metaconid and entoconid of M_2; mesoloph

absent; cusps of two sides not at same level at all stages, for in slightly worn lower molars, lingual cusps more elevated than labial cusps; both series of cusps with wear become equal in height, and pattern soon becomes obliterated. M^1 with well-developed anterocone, usually with shallow anterior median fold, and with exteroanteroloph (referred to as anterior cingulum by most authors) fused with anterocone and an outer anterostyle; anterostyle fused with paracone, cutting off first primary fold (see Hershkovitz, 1944, fig. 1, for this terminology) and forming lake; posterolabial edge of paracone continuous with metacone, cutting off second primary fold and forming second lake in M^{1-2}. M^2 with anterocone absent but exteroanteroloph and outer anterostyle present; minor fold anterior to protocone absent. M^3 resembles M^2, but hypocone reduced and major fold, anterior to it, absent. In lower teeth, mesostylid absent; posterolophid (referred to as posterior cingulum by most authors), at early stages of wear, slightly separated from hypoconid by shallow posterolabial fold in M_{1-3}; metaconid and protoconid (of M_2, at least) nearly opposite one another when tooth worn; small, accessory cuspid, situated on side of hypoconid near base of major fold, so short that occlusion not established until tooth much worn; M_3 with accessory lophids and folds not greatly reduced, resulting in pattern typical of cricetine mice but unlike the S-shaped or dumbbell-shaped pattern of cricetine wood rats. Anterior palatine foramina extend posteriorly on palate to level of minor fold of M^1; groove between anterior and posterior palatine foramina deep, apparently for transmission of palatine artery and nerve.

Comparisons.—Pliotomodon primitivus differs from *Peromyscus* and closely related brachydont forms as follows: teeth higher crowned; anterocone, paracone, and metacone connected along labial side; cusps elongated anteroposteriorly; mesoloph and posteroloph absent; metaconid of M_1 apparently with anterior fold separating it from anteroconid; fold posterior to entoconid of M_3 better developed; cusps along both sides of tooth more nearly of same height; minute accessory cuspid on side of hypoconid. *Pliotomodon* resembles brachydont cricetines in the following features: anterocone of M^1 extends transversely across tooth and possesses anterior median fold; anterocone and paracone connected along labial side by anterostyle, thus enclosing first primary fold, but connection broader and more elevated than in brachydont forms; M_3 not greatly reduced, with typical brachydont type of pattern; loph from protoconid-entoconid connects to labial side of hypoconid; posteroloph of lower teeth directed posterolabially.

Pliotomodon differs from *Neotomodon* as follows: cusps more elongate anteroposteriorly; outer cones of M^{1-2} connected along labial side, forming two lakes, whereas in *Neotomodon* connection between anterocone and paracone appears only with advanced wear, forming one small lake; anterocone partially divided (with anterior median fold); folds of lingual side of upper teeth less compressed; M^3 not greatly reduced in size; loph from protoconid-entoconid connects to labial side, not middle, of hypoconid; posterolophid separate from entoconid until wear so advanced that outline of individual cusps no longer persists; M_3 without S-shaped pattern, but with two lingual folds. *Pliotomodon* resembles *Neotomodon* as follows: teeth high crowned; cusps lose their individuality with slight wear; lophs connecting cusps broad.

Pliotomodon differs from all wood rats, and *Tretomys* and *Ptyssophorus* of the Pleistocene of South America, as follows: anterocone large, extending transversely across anterior portion of tooth, with anterior median fold; cusps of upper teeth connected labially, resulting in isolation of lakes (absent in wood rats or lakes present only in extremely advanced stages of wear); cusps of upper teeth, other than anterocone, arranged more nearly opposite one another; loph from protoconid-entoconid connects to labial side of hypoconid; anterolophid better developed and present even in M_3; lingual cusps of lower teeth slightly more elevated than labial cusps at early stages of wear; shallow fold present separating hypoconid from posterolophid in M_{1-2}. *Pliotomodon* resembles wood rats as follows: teeth hypsodont; mesoloph absent; posteroloph fused with metacone; lophs connecting cusps broadened with result that cusps lose their individuality with wear.

Pliotomodon primitivus differs from *Scottimus lophatus* Wood (1937, p. 255) of the White

River Oligocene as follows: anterocone and paracone in M^1 connected along labial side of cusps; protoloph present, connecting paracone and protocone, whereas in *Scottimus* protoloph is absent in M^{2-3} and two internal folds unite to form one large lake; posterolophid of lower teeth better developed and not fused with entoconid; mesolophid absent; entoconid situated farther anteriorly. *Pliotomodon* resembles *Scottimus* in connection between paracone and metacone.

Pliotomodon primitivus differs from *Cricetodon sansaniense decedens* Schaub of the La Grive Vindobonian (as known from Schaub's description and figure 2, pl. 3, 1925, of M^{1-2}) as follows: connection, labially, between anterocone and paracone complete rather than incomplete; two lakes present whereas anterior lake (first internal fold) absent in *C. s.*

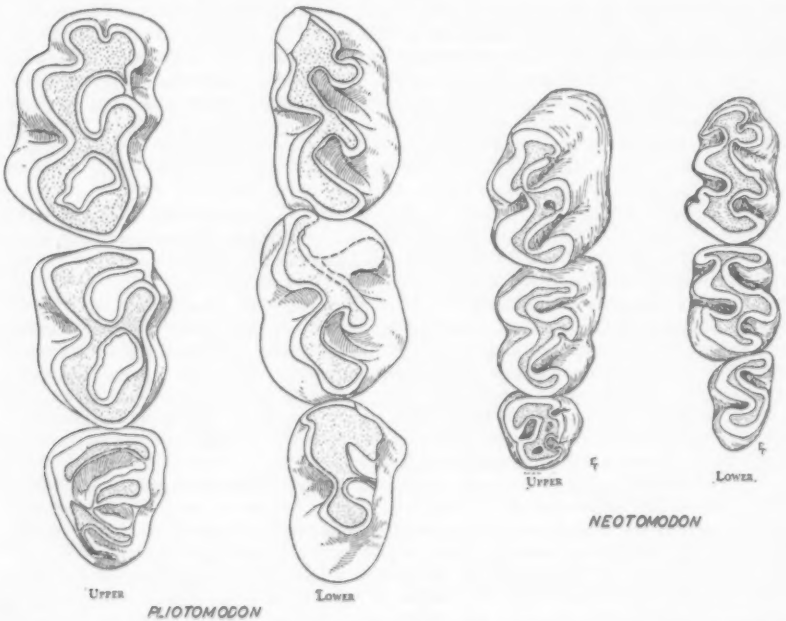

FIG. 1. Occlusal view of molar teeth of *Pliotomodon primitivus:* uppers, with medium wear, no. 36030, lowers, with slight wear, no. 37535, both in Univ. Calif. Mus. Paleo., from the Middle Pliocene Mulholland Fauna, California; and *Neotomodon alstoni:* with slight wear, no. 50572, U. S. Nat. Mus., from Salazar, Mexico, Mex. All, × 10.

decedens; protoloph-connection of paracone narrower. *Pliotomodon primitivus* resembles *Cricetodon s. decedens* more closely than any other Palearctic Tertiary cricetine, such resemblances being: anterocone of M^1 with anterior median fold; exteroanteroloph well developed (even if not continuous with paracone in *C. s. decedens*); paracone and metacone joined along labial side; cusps narrowed and elongated anteroposteriorly; posteroloph absent (may be result of advanced wear in figured specimen of *C. s. decedens*).

Remarks.—Pliotomodon primitivus is the only Tertiary cricetine in the Nearctic region known to combine the hypsodonty of the teeth of cricetine wood rats with the dental pattern of the cricetine mice. Thus, of all species, *P. primitivus* might well be considered as most nearly intermediate between the mice and wood rats.

The more important resemblances to, and differences from, the mice and the wood rats have been listed in the foregoing comparisons. The teeth of *Pliotomodon* are, to some degree, structurally intermediate between the teeth of the rats and mice in that the series of cusps are elevated, yet only slightly. Also, the breadth of the lophs connecting the cusps is intermediate between the breadth in the mice and wood rats. In wood rats there is no difference in height of the cusps of the two sides; in mice having brachydont teeth, the lingual cusps in the lower teeth and the labial cusps in the upper teeth are more elevated than are the cusps on the opposite sides of these teeth. Whereas the lingual and labial cusps of the upper teeth of *Pliotomodon* are equally, but only slightly, elevated, the lingual cusps in the lower teeth are more elevated than the labial cusps. If the series of upper teeth were as little worn as is the only known series of lower teeth, the labial cusps of the upper teeth might be higher than the lingual cusps.

Lower teeth of *Pliotomodon primitivus* have not been found in association with upper teeth, upon which the species is based. The lower teeth assigned to this species correspond closely in expected structure with the upper teeth, with the important exception that in the lower teeth there is no connection of the lateral margin of the cusps at their occlusal surface and also in the difference in height of the cusps of the two sides. Regardless of these exceptions, the lower teeth are referred to *P. primitivus*. These peculiarities of the lower teeth result in a pattern more nearly intermediate between those of wood rats

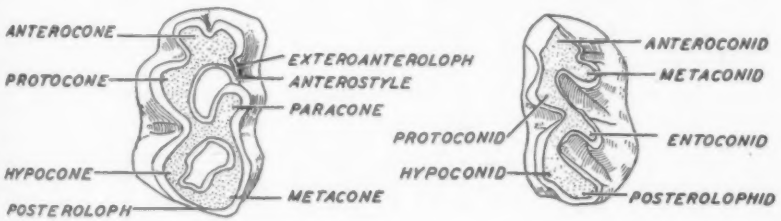

FIG. 2. Occlusal view of first upper molar (*A*) and first lower molar (*B*) of *Pliotomodon primitivus* with parts labelled.

and mice than is the pattern of the upper teeth, primarily because the folds of the lower teeth are open, rather than closed off, along the lateral margin of the tooth and, secondarily, because the differences between the lower teeth of mice and rats are not as great as those between the upper teeth of the two.

The extension posteriorly of the anterior palatine foramina to the level of the anterointernal reëntrant angle of the first upper molar resembles more closely the condition in most mice although in a few wood rats these foramina extend equally far posteriorly. In no other Nearctic cricetine with which I am familiar is the groove that extends anteriorly from the posterior palatine foramina as deep as it is in *Pliotomodon primitivus*.

Even though *Pliotomodon* does resemble the wood rats in some features, and is intermediate between wood rats and mice in others, the total resemblance to the cricetine mice is greater than to the wood rats. Such features as the anterior median fold of the anterocone, the pattern of M_3, the labial connection between anterocone and paracone, the connection of the loph from the protoconid-entoconid to the labial side (not middle) of the hypoconid, and the difference (even if slight) in height of the cusps on opposite sides of the tooth are as in brachydont forms of cricetine mice. Therefore, *Pliotomodon* is considered to be a cricetine mouse in which hypsodont teeth, much as exist in the genus *Neotomodon*, evolved to meet dietary needs. Any resemblances to molariform teeth of wood rats are thought to be a secondary result of this hypsodonty.

TABLE 1.—*Measurements of molariform teeth of selected cricetine rodents*

				ANTEROPOSTERIOR LENGTH[1]								WIDTH ACROSS FR-PA			WIDTH ACROSS PR[d]-EN[d]		
				M^{1-3}	M^1	M^2	M^3	M_{1-3}	M_1	M_2	M_3	M^1	M^2	M^3	M_1	M_2	M_3
Pliotomodon primitivus	U.C.* No. 36030 (type)	Medium wear	Mulholland	8.3	3.1	2.45	1.8					1.55	1.7	1.3			
" "	U.C. No. 37632	Much worn	"		3.3							2.05					
" "	U.C. No. 37633	" "	"				2.55										
" "	U.C. No. 37535	Slightly worn	"					8.15	2.75	2.7	1.9				1.5	1.6	—
Neotomodon alstoni	M.V.Z. No. 91971	Much worn	Mexico, Mexico	5.25	2.2	1.55	0.8	5.35	2.15	1.7	1.4	1.3	1.3	1.0	1.5	1.4	—
Neotoma lepida	M.V.Z. No. 94798	Worn	Alameda Co., Calif.	8.15	3.1	2.3	1.5	7.8	3.05	2.4	1.3	2.0	1.8	1.45	1.5	1.65	—
Peromyscus sp.	U.C. No. 37623	Much worn	Mulholland	2.9	1.1[2]	1.0	0.7										
" "	U.C. No. 37624	Slightly worn	"							1.3						0.85	
Peromyscus antiquus	U.C. No. 12571 (type)	" "	Thousand Creek					5.4	1.9	1.7	1.25				1.0	1.2	1.05
Peromyscus near *antiquus*	C.I.T. No. 1812	" "	Smiths Valley					5.6	1.8	1.7	1.3				1.05	1.1	0.9
Peromyscus pliocenicus[3]	C.I.T. No. 1967		Kern River					6.1	2.3	2.0	—						
Peromyscus ? sp.	U.C. No. 12573 (no teeth)		Thousand Creek					3.5[2]									
" "	U.C. No. 12574 (no teeth)		" "					3.6									

[1] Anteroposterior length of M^{1-3} and M_{1-3} is greatest alveolar length; all other measurements are at the occlusal surface.
[2] Approximate.
[3] Measurements from Wilson (1937:16)
* U.C., University of California Museum of Paleontology; M.V.Z., Museum of Vertebrate Zoology; C.I.T., California Institute of Technology.

The resemblances between *Pliotomodon primitivus* of the Middle Pliocene of North America and *Cricetodon sansaniense decedens* of the Middle Miocene of Europe may not ndicate a close relationship between the two genera but rather parallel adaptive changes in two distantly related and isolated stocks.

Peromyscus sp.

A part of a left maxilla bearing much worn M^{1-3} and an isolated, little-worn left M_2, Univ. Calif. Mus. Paleo. numbers 37623 and 37624, respectively, both from the Mulholland quarry designated as site 2 (loc. no. V-3611), are referred to the genus *Peromyscus*. These teeth closely resemble those of *Peromyscus* and differ from those of *Onychomys* as follows: M^3 retains more pattern and is relatively larger, for a worn tooth, and M_2 has the labial row of cusps more flattened. The upper teeth apparently possess a mesoloph, and in this differ from those of *Baiomys*, *Reithrodontomys* (subgenus), and *Haplomylomys* (subgenus). However, because of advanced wear, it is impossible to be certain that a mesoloph existed in the upper series from the Mulholland Fauna. If the isolated lower molar does not belong to the same species as does the upper molar series, then the specimen represented by left M_2 may be of the genus *Peromyscus*, *Baiomys*, or *Reithrodontomys*. The lower M_2 differs from M_2 of *Symmetrodontomys* in much the same way that this tooth differs from those of *Onychomys* and *Bensonomys*, namely in that the bottoms of the reëntrant angles or folds are not so flat and in that the cusps rise higher above the base level of the crown.

Two species of *Peromyscus* are known from Middle Pliocene deposits, *Peromyscus antiquus* Kellogg (1910, p. 432) and *Peromyscus pliocenicus* Wilson (1937, p. 15). To me the species *Peromyscus martinii* Hibbard (1937, p. 464), from Middle Pliocene Beds, appears to be of the genus *Onychomys* (*Onychomys martinii*). The two specimens from the Mulholland Fauna differ from *antiquus* and *pliocenicus* in smaller size and less hypsodont teeth. This latter feature is noteworthy because in both *antiquus* and *pliocenicus* the teeth are markedly more hypsodont that in Recent species of *Peromyscus*, whereas in the two specimens from the Mulholland Fauna there is no noticeable difference in height of cusps when compared with Recent forms. Probably the Mulholland specimens are nearer the main phyletic line of *Peromyscus* and represent a species other than *antiquus* or *pliocenicus;* they may belong to the same species as do the parts of two edentulous jaws, listed by Kellogg (1910, p. 433) as *Peromyscus* ?, sp. from the Thousand Creek beds of Nevada. Possibly the two specimens from the Mulholland Fauna are of two different species because the difference of 0.3 mm in length between M^2 and M_2 (1.0 mm and 1.3 mm, respectively) is greater than expected between two individuals of the same species. However, M^2 may be this much smaller because of the greater wear, resulting in the loss of much of the cingulum around the tooth.

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Museum of Natural History, Lawrence, Kansas.

GENERAL NOTES

OBSERVATIONS ON THE EASTERN MOLE IN CAPTIVITY

A common eastern mole (*Scalopus aquaticus*) was captured by the gardener's force in the National Zoological Park about June, 1942. It was placed on exhibition in the small mammal house, but since moles are so common and rarely live in captivity more than a few days, it was not accessioned.

This specimen thrived in captivity until November 1943, at which time it was found dead, with the claws of its left forefoot in a small crack of the cage. Apparently it either starved to death in the few hours before it was found, or fretted itself to death.

From the time of its capture until its death it was kept in a cage 11 x 14 inches floor space, with glass front and back, and ¼ inch mesh woven wire sides. About two inches of soil was kept on the floor of the cage, moistened occasionally and changed at intervals. About 75 meal worms, weighing ½ oz. 34 grains, were dropped on the soil twice a day, and once a day a ball of horsemeat weighing about ½ oz. 64 grains was dropped on the soil. Perhaps half of the 150 meal worms a day escaped through the wire ends of the cage, but all of the meat was eaten. Its diet, therefore, was between ½ and ½ oz. of meal worms, and about ½ oz. 64 grains of horsemeat a day.

The mole worked through the soil almost constantly, and became rather fat, weighing at death 3 oz. 73 grains.—Ernest P. Walker, *Assistant Director, U. S. National Zoological Park, Washington, D. C.*

FURTHER REMARKS ON THE OPOSSUM IN NEW YORK

By way way of supplementing the remarks of W. J. Hamilton, Jr. and of the writer in this journal (vol. 14, no. 2, pp. 151–152, 1933 and vol. 20, no. 2, pp. 250–251, 1939, respectively) regarding the northward extension of range of the opossum in New York State, the following recent records and other information are offered. These data have been accumulating in the State Museum files during the past five years and their presentation now provides another step in the recorded chronology of the slow but steady establishment of the animal in our colder sections.

Since February 14, 1939, the latest date of capture of an opossum reported by me in 1939 (see *ante*), records of the occurrence of the animal in Albany, Fulton, New York, Saratoga, Sullivan, Westchester, and Yates counties have come to my attention. Three of these records are for animals killed on the highways, one at Bluff Point, Yates County, December 1940 (Hazel R. Ellis), one at Latham, Albany County, November 11, 1942 (Stoner); and the other at Greenfield Center, Saratoga County, "about November 25", 1943 (Joseph Bruchac).

Other records for Albany County pertain to an adult captured alive March 23, 1942, and an adult seen in the village of Menands on the night of October 31, 1942. The New York County record is that of an individual taken alive at 89 East Tenth Street, New York City, March 18, 1941.

With reference to the Saratoga County specimen Mr. Bruchac, a taxidermist at Greenfield Center, writes under date of March 4, 1944, that this was the only opossum brought to him during the past six months. The animal, a female, was very fat and weighed "about seven pounds"; it was discovered in the highway by Captain C. E. Pegram for whom Mr. Bruchac tanned the skin.

By way of illustrating the wandering and inquisitive propenisities of the opossum, George Dock of Scarsdale (Westchester County) reports that between October 1, 1939, and October 1, 1940, he captured four of the animals in his back yard in traps set for taking birds for banding. All the animals were adult, three males and one female. About January 20, 1942, he captured another male under similar circumstances.

Under date of March 15, 1943, Raymond T. Fuller of Winterton (Sullivan County) reported that during the preceding two years he had caught four opossums in his bird banding

traps. One of the animals was less than a year old. A large male also was similarly captured by him on April 10, 1943. In commenting further on the current status of the species in his territory Mr. Fuller writes: " . . . . The country folk hereabout seem invariably to kill them [opossums] whenever discovered" and they are "regarded as the chief poultry marauder. Whereas some twenty years ago they were rarely if ever seen, for the past ten years especially they are steadily becoming more numerous and appear to winter successfully. . . . They inhabit the burrows of hares and woodchucks during winter, appearing about once a week to forage in the neighborhood. Have never seen young ones less than half-grown."

Probably the most interesting and, at the same time, important portion of this communication has to do with the evidence for the "fartherest north" New York State point from which very small young have been reported.

Under date of July 23, 1943, F. L. Teall of Little Falls, New York, wrote me as follows: "I am at Fourth Lake of the Fulton Chain. Last night at about eleven, I snapped on the kitchen light and clinging to the screen door was a baby opossum, about 4 inches long. We find droppings on the porch each morning . . . ." In response to certain specific and detailed questions which I transmitted concerning his observation, Mr. Teall replied that "There is no question about the identification as the opossum did not move when the light was on it. Had plenty of time to look it over and could easily have picked it off the screen."

Recently I received through the courtesy of Dr. Gordon M. Meade the skinned carcass of an adult female opossum killed December 26, 1943, near Geneseo, Livingston County, New York. Visible evidence of developing young in the sex organs was lacking. The stomach of the animal was about two-thirds filled with grass, rootlets and other vegetation. Also, included in the mass of ingested material were fragments of an earthworm, an insect puparium and the feathers of a domestic fowl. In addition, there were present about 25 examples of a parasitic nematode worm determined by Dr. E. W. Price of the U. S. Bureau of Animal Industry as *Physaloptera ackerti* Hill, 1939. The smallest worms were about 10 mm in length, the largest approximately 35 mm. This is the first time that I have come upon this parasite in opossums in this state.

The foregoing data provide further evidence of the northward extension of the opossum's range in New York State and of the apparently successful breeding of the animal at approximately 43° 50′ north latitude in eastern New York.—Dayton Stoner, *New York State Museum, Albany, New York.*

RAT FOSTER MOTHER OF MICE

From time to time cases are reported in which an animal of one species has nursed or cared for the young of another species. Foster parents are very common among birds, for in fact the cuckoos of the old world and our cowbirds habitually depend upon other birds, especially the smaller species, to rear their young.

Man frequently imposes on his domestic dogs and cats the rearing of the young of wild animals that he has caught and wishes to raise. In some cases, women, especially natives, have been prevailed upon to nurse the young of rare or valuable monkeys and apes whose mothers have been lost or killed.

Some years ago, a litter of six young mice (*Mus m. musculus*) was found in the hay in the feed room of our animal laboratory. Since the laboratory at that time was not rat and mouse proof, it was not known whether the mother of the litter was an animal that had escaped from our cages or was one from the outside.

We wished to rear the litter but we had no mice with young at the time, so we decided to give the young mice to a lactating albino rat (*Rattus norvegicus albinus*). This rat was nursing nine young of her own, which were about one week old. The young rats were more than twice the size of the young mice, but we decided to see how the rat might react to the mice. One young mouse was placed in the cage of the rat to see what she would do with it, for we anticipated that there might be some antipathy between the two species, which might result in the rat killing and eating the young mouse.

When the mouse was placed in the rat cage, and it began to squirm around, the rat left her litter in the rear corner of the cage, walked forward to the mouse and sniffed at it. She then picked it up in her mouth, reared on her hind legs and tail, handled the mouse with her fore feet and thoroughly licked the little animal. This accomplished, she again took the mouse in her mouth, carried it to the rear of the cage and placed it among her own litter in her nest. Another young mouse was placed on the floor of the cage and she repeated the whole procedure. Each of the six young mice was received in the same manner and eventually all six were added to her litter in her nest.

Because of the great difference in the size of the young rats and the young mice, because of the considerable difference in size between the nipples of the mother mouse and those of the mother rat, and because we expected the nine larger rats to crowd the smaller mice away from the nipples, we expected soon to see the mice show signs of malnutrition.

The whole procedure had happened so quickly and with such unexpected results, that we had not thought to weigh the mice before giving them to the rat. The following day they were weighed and at that time they still seemed to be in good condition. The fourth day their weights showed that they were growing nicely. Successive weighings recorded a steady growth of all 15 of the rats and mice. The young house mice grew to maturity along with the rat family and finally gnawed through the wooden door and made their way out of the rat cage, where they were free in the laboratory.

To all appearances, the maternal instinct of the rat led her to accept these young mice and treat them just as she did her own. There seemed to be no antipathy between the white rats and the house mice, but whether the same holds true for the brown or gray rats and the house mice may be questioned. Further experimentation along this line might bring out some interesting details and the writer contemplates this for the near future.—Albert R. Shadle, *Department of Biology, University of Buffalo, Buffalo, New York.*

WATER SHREW IN ALLEGANY STATE PARK, NEW YORK

July 23, 1944, the writer trapped an adult female *Sorex palustris albibarbis* (Cope) in Allegany State Park, Cattaraugus County, New York. The precise locality is Stoddard Brook, one mile south of Red House Lake, in a shady ravine at 1,600 feet elevation. The water shrew appears to be new to western New York, the nearest previous localities being in the Catskills and northeastern Pennsylvania. It is probable that the species occurs elsewhere in the Park, and also in the adjacent Allegheny National Forest in Pennsylvania. —Theodore H. Eaton, Jr., *University of Buffalo, Buffalo, New York.*

THE RED BAT IN ARIZONA

Seemingly the red bat, *Lasiurus borealis teliotis*, is of rare occurrence in Arizona. I have been able to find only two published records of its capture in that state (Hargrave, Jour. Mamm., vol. 25, no. 4, p. 414, 1944, and Allen, Bull. Amer. Mus. Nat. Hist., vol. 7, p. 246, 1895). Both of these records are for Cochise County in the southeastern corner of the state. To these I wish to add other records known to me.

A specimen from Tucson, Pima County, is in the Texas Cooperative Wildlife Collection. This bat was captured by Mr. S. F. Hyde on June 14, 1933, at the Southern Pacific depot. Through the courtesy of Dr. H. H. T. Jackson of the Fish and Wildlife Service, I learned that on July 21 and 23, 1902, Frank Stevens collected three females of this race at Big Sandy Creek, in southern Mohave County, some 50 miles east of Topock. Dr. Jackson collected a male on August 6, 1916, at Montezuma Well, Yavapai County, and on August 21, 1923, E. A. Goldman collected a female at Ramsay Canyon, Huachuca Mountains, Cochise County. These last five specimens are in the Biological Surveys Collection, U. S. National Museum.—William B. Davis, *Department of Fish and Game, Agricultural and Mechanical College of Texas, College Station, Texas.*

RECORD OF A PORPOISE NEW TO THE ATLANTIC

The occurrence of *Lagenorhynchus electra* Gray in the Equatorial Atlantic seems of sufficient importance to put on record. All other specimens of which the history is known are from Indian and tropical Pacific Oceans, although in "Osteographie des Cetaces" indefinite reference is made to a specimen from the Golfe de Guinée.

The exact locality, measurements, and notes on the color of the present specimen are recorded as follows: No. 43000 Amer. Mus. Nat. Hist., fully mature male; lat. 03° 03′ N., long. 24° 40′ W.; Atlantic Ocean, Oct. 10, 1912; collector, Robert Cushman Murphy; complete skeleton.

Color.—Black, except for four stellate white marks on each side of the head: one in front of the flipper, one below the eye, one at corner of mouth and one on side of throat; a whitish lower lip and a broken white band extending from the umbilicus through the genital slit to anus. This specimen showed no indication of a beak and the posterior ventral region was greatly swollen due to the large size of the testes which were eighteen inches long and weighed more than ten pounds.

PLATE 1

Adult male of *Lagenorhynchus electra*, drawn from a specimen by Robert Cushman Murphy.

External measurements taken in the flesh.—Total length, snout to notch of flukes, 273 cm; snout to right eye, 37.2; snout to right corner of mouth, 30; snout to spiracle, 40.6; snout to anterior insertion of pectoral, 57.5; snout to anterior base of dorsal, 117.8; snout to anus, 187; length of pectoral, anterior insertion to tip, 49.4; breadth of pectoral, anterior insertion to axilla, 16.7; distance apart of anterior bases of pectorals, 25.4; length of base of dorsal, 44; vertical height of dorsal, 22.8; spiracle, tip to tip, 4.4; mouth, corner to corner, 24.5; length of eye opening, 2.9; distance of eye above line of mouth, 3.8; eye to spiracle, 22.5; flukes, tip to tip, 62.5; length of right lobe, 35.6; length of left lobe, 34.5; greatest cephalo-caudal breadth of flukes, 22; depth of body at point 40 cm from notch of flukes, 22; depth of body at point 80 cm from notch of flukes, 40.5; depth of notch of flukes, 3.8; genital organ to anus, 34.5; girth of head at eyes, 101; girth at anterior insertion of pectorals, 120.5; girth at posterior insertion of dorsal, 124.7; girth at anus, 104.6.

Dentition.—$R\frac{3}{4}\frac{5}{4}$, $L\frac{3}{4}\frac{5}{5}$; vertebrae: C. 7; D. 13; L. 19; Ca. 42.

Measurement of skull (type in parentheses).—Greatest length, 490 mm (457); length of beak, 268 (243.5); breadth of beak at base, 143 (139.5); interorbital width, 257 (252); alveoli of upper toothrow, 195 (181); alveoli of lower toothrow, 170 (168).

The skull, rather larger than the average, shows all the characteristics of *L. electra*, especially in the peculiar shape of the lower jaw and the broad long rostrum.—George G. Goodwin, *American Museum of Natural History, New York, New York.*

TADARIDA MEXICANA IN OREGON

The presence of *Tadarida mexicana* in Oregon has been recorded previously. H. H. Shamel, in his paper "Notes on the American bats of the genus *Tadarida*" (Proc. U. S. Nat. Mus. vol. 78, art. 19, pp. 1-27), lists a skin from "Fort Dallas," Oregon. I have been unable to find any record of the taking of this specimen, or to determine where it was deposited. According to Shamel, the Rand McNally Index Atlas shows Old Fort Dalles to be located at The Dalles, Oregon. Shamel states that the specimen in question is not in the collection of the U. S. National Museum and that the only other specimens he used in his study were from the American Museum of Natural History. An inquiry to the American Museum has revealed that the specimen does not exist in that collection. In view of the information at hand, the validity of the Fort Dalles record is questionable.

The search for the skin from Fort Dalles was brought about because of the recent collection of a specimen of *Tadarida mexicana* from southern Oregon. On October 1, 1940, Dennis Constantine procured a specimen of *Tadarida mexicana* from its roost under the roof of the laundry of the Sacred Hearts Hospital in Medford, Oregon. The lone free-tail was found roosting with several *Antrozous pallidus* (subsp. ?). Constantine made a skin of the bat and presented it to Dr. Huestis, of the Department of Zoology, Oregon State College, Corvallis, Oregon. Mr. Stanley G. Jewett of Portland, Oregon, upon my request, examined the specimen for me and states that the skin was made up with the skull left in it and that the tail vertebrae were not removed. The sex was not recorded.

This specimen constitutes an authentic record of the presence of *Tadarida mexicana* in Oregon.—Kenneth E. Stager, *Los Angeles Museum, Los Angeles, California.*

OBSERVATIONS ON A COLONY OF MOLOSSIDS

On March 23, 1943, Henry Weston, a friend of mine, had the good fortune of discovering a colony of two uncommon molossids, *Tadarida femorosacca* and *Eumops perotis californicus*. These free-tailed bats were found to be inhabiting the recesses of a crack in a large granite boulder three miles southeast of Suncrest, San Diego County, California. This separation in the rock is vertical in nature, three inches wide at its lower extremity and varying from one to two inches wide at its culminating point. When an attempt was made to capture specimens, the *Tadarida femorosacca* were taken in the upper limit of the crack; *Eumops*, at the lower, wider end.

A second visit made to the colony on May 9, 1943, produced similar results. *Tadarida* were in the higher, narrower part of the crevice and *Eumops* in the lower, wider portion.

In neither of the two observations of the colony were both genera found to be living together. The definite segregation, yet close proximity, of these two species seems to indicate the possibility of an antagonistic relationship.—Philip H. Krutzsch, *1536 31st Street, San Diego, California.*

THE OCCURRENCE OF CASTOROIDES IN THE PLEISTOCENE OF KANSAS

In December 1940, the writer was fortunate to find an almost complete left tibia-fibula (the upper end missing), KUMVP no. 6893, in a Pleistocene deposit in Sheridan County, Kansas located along the south side of the North Fork of the Solomon River belonging to the genus *Castoroides*. This represents the third known occurrence of the genus in Kansas. The measurements are as follows: overall length, incomplete, 181.0 mm; greatest width, distal end, 48.5 mm; length fibula co-ossified with tibia, 91.6 mm. These measurements compare favorably with those given by Hay (Iowa Geol. Survey, vol. 23, ann. rept., p. 462, 1912). A skull, KUMVP no. 3196, the type of *Castoroides kansensis* Martin (Univ. Kans. Sci. Bull., vol. 6, pp. 389-396, pls. 24-27, 1912), from Boicourt, Linn County, Kansas, was the first described. A fragmentary incisor, KUMVP no. 6296, was found in the Rezabek Fauna of Lincoln County, Kansas (Hibbard, Univ. Kans. Sci. Bull., vol. 29, pt. 2, no. 2, 1943). The Sheridan County specimen was associated with a large number of mollusks.—Morton Green, *Museum of Vertebrate Paleontology, University of Kansas, Lawrence, Kansas.*

TECHNIQUES IN TRAPPING SHREWS

Everyone who has had trapping experience has lost many valuable specimens by the jaw of the trap passing completely over shrews, allowing them to escape unscathed.

In the course of recent trapping, I developed two techniques for increasing the catch of and decreasing skull damage to small shrews. For these techniques I wish to thank Mr. J. S. Findley and the late Phillip Nelson Moulthrop who urged my development of a new technique.

The first of these methods consists of attaching a wire grid over the jaw of the mouse-trap. This is quickly done by taking 20 to 24 gage soft wire and twisting one end of the wire on the far outside corner of the jaw and soldering it; then stretching it tightly diagonally across the jaw so that it crosses over the pan and soldering it, then stretching it back across the jaw over the pan to the opposite side, winding tightly and soldering. The wires tend to pinion the shrew rather than crush its skull and to eliminate the "overspring" of these traps. For shrew trapping I also recommend that the trap pan be shortened. This can be done by using a coping saw to cut off half the wood pan and tin snips to remove the metal underneath.

The second technique deals with the baiting of the trap. Most collectors, I believe, do not put enough emphasis on the bait they use or overlook it entirely. I think that the bait is essential. A cube or slice of bacon smeared liberally around the pan, on it, and underneath it is efficient and a one inch cube of bacon can be used to bait one hundred or more traps.

Using these techniques, 10 *Sorex cinereus ohionensis* were collected in one night, where in two previous years a total of only 6 were collected.—C. Arthur Foster, *17873 Lake Road, Lakewood, Ohio.*

SWIMMING ABILITY OF A WOOD MOUSE

Early in April 1941, while collecting frogs at about dusk along Tacony Creek, northern Philadelphia County, Pennsylvania, I noticed two northern wood mice (*Peromyscus leucopus noveboracensis*) chasing each other on the limbs of an old dead tree that had fallen partway across the creek. One mouse quickly cornered the other and forced it to dive into the water. This mouse swam nearly 10 feet downstream before it caught sight of me on the bank. In swimming, the front feet and tail dragged, the hind feet provided propulsive power by being kicked rapidly up and down. The head was kept well above water. The current seized it for a second, but the mouse seemed to have the situation in hand. When it noticed me, it dived, jack-knife fashion, with a loud "plop", and headed for the far shore underwater. I waded in, hoping to capture it, but I had scarcely reached midstream when the mouse scrambled up the opposite bank and scurried off through the underbrush. The stream at this point was well over 30 feet wide, waist deep, and the current strong. The fact that the mouse did not seem inconvenienced by the swift water seems to prove that wood mice may well be more aquatic than formerly believed.—Robert Teeters, *Philadelphia Zoological Garden, Philadelphia, Pennsylvania.*

NUMBERS OF YOUNG IN THE COMMON BLACK AND GRIZZLY BEARS IN WESTERN CANADA

Thompson Seton, in his "Lives of Game Animals, 1909", refers to two authenticated instances of quadruplets in the black bear (*Euarctos americanus*); both lots born in captivity of the same parents at Akron, Ohio. He also quotes Richardson to the effect that the young of black bears run from one to five. In no other reference work known to me is there any suggestion that more than three ever occur. The following brief note thus appears worthy of publication although there seems no reason to suppose that the cases here recorded should be unique.

Jasper National Park, on the eastern slope of the Rockies in west-central Alberta, like some other national parks, has a super-abundant population of black bears. They thrive in its "artificial" environment, feeding mainly at two substantial garbage dumps during

the summer and sleeping off the winter under local buildings such as the spacious cabins of Jasper Park Lodge, one of Canada's most luxurious hotels. Both the Lodge and the village dumps are extensively patronized, as many as 30 bears being occasionally in view at one moment at either of them. Hand-feeding of the tamer individuals is also a common practice, especially around the Lodge, where the animals are objects of popular entertainment with visitors. Many of the regular *habitués* that return to the Lodge year after year are sufficiently familiar to have earned themselves pet names. Among them is a female brown bear known as Peggy. She is unusually tame and has at least twice, during my years of acquaintance with Jasper, produced triplets. Last year (1943) Peggy turned up with four. The Lodge was then closed (for the duration): in substitution she systematically frequented the village itself, where the accompanying photograph (Pl. 2) was obtained in June 1943 by Jasper's well known pictorial photographer, Morris Taylor, to whom I am indebted for permission to publish it. The picture was taken shortly after Peggy had tried to invade a trans-continental dining car with her entire retinue! One of these subsequently suffered a broken leg, but, along with the rest, nevertheless survived the winter. The leg is now set

PLATE 2

Peggy and her four cubs. Photo by Morris Taylor.

and again in full use, although it sticks out at a slight angle. Three of the young are brown, the fourth black.

Peggy, however, was not destined to enjoy her distinction for long, for within two weeks of this picturesque emergence from hibernation another bear with quadruplets put in an appearance. The cubs were considerably smaller than Peggy's and all were black, like their mother. Of the previous history of this bear I know nothing, but she was shy of the village and frequented a beat about five miles out at Lake Edith where I obtained a photograph of the four cubs up a tree. Attempts to chase the mother up the tree after the cubs for a picture proved unavailing. She stolidly refused to oblige, but was not in the least belligerent—evidently another old-timer well accustomed to human attention.

One of the cubs had a small white crescent at the base of the throat. This spring a bear came by our cottage with three black cubs in their second year, one of them with an exactly similar crescent on precisely the same spot. I have little doubt that these were three of the four, the fourth having presumably come to grief.

While these two families were roaming Jasper Park in 1943, yet a third bear with quad-

ruplets was frequenting Banff National Park 200 miles farther south. Kodachrome pictures of these were procured by a friend. Although I have not personally seen them, the case seems beyond question.

In the meantime I have obtained three other records of quadruplet cubs in the black bear, all, I have reason to believe, entirely dependable. The first comes from a ranger in southern Alberta (1926), the second from the forks of the Athabasca and Pembina Rivers (*circa* 1936; W. Smith of Fawcett, Alberta) and the last from the headwaters of the Boiler River, N. W. T. (1942; W. L. MacDonald of Yellow Knife, N. W. T.). Two of the last were brown and two black.

These records are, however, topped by a case noted by Major J. A. Wood, now superintendent of Jasper Park, but at that time in charge of Prince Albert Park, Saskatchewan, where a bear with five cubs of the year, all of similar size, was seen crossing a road. Major Wood was at the time with a ranger and there is no doubt of the number. It would seem much more probable that these were the product of a single animal than that any of them should have been adopted, a quite unlikely event among bears.

As far as numbers of cubs are concerned in Jasper Park, I would unhesitatingly say that the most frequent number is one while two are very common, three probably of annual occurrence, and four extremely rare; five must be most exceptional. While I have no statistical evidence that this estimate is correct, the resident rangers fully concur. Cubs are typically produced biennially, running with their mother for two seasons.

One of the Park rangers, Mr. Ed. MacDonald, who has spent many years at the higher altitudes in Jasper Park, tells me he has known at least two instances of triplets in grizzly bears (*Ursus horribilis*) within the park boundaries, while twins are fairly common, with singletons the most frequent. Seton (*loc. cit.*) records four "in one or two extraordinary cases" but gives no details.—William Rowan, *University of Alberta, Edmonton, Alberta.*

FOOD HABITS OF THE GOLDEN HAMSTER

New and interesting information regarding the food habits of the golden hamster (*Cricetus auratus* Waterhouse) was recently obtained when a six weeks old female got out of a cage in our apartment. The little animal was loose for seven days and considered dead from starvation when it finally returned with full cheek pouches. It was induced to expel the contents of its pouches and the following were found: 13 sow bugs, 7 ants, 4 cockroaches, 2 flies, and 1 hornet. Ever since Aharoni's paper in 1932, golden hamsters have been known to be unusually omnivorous, but no one has suggested that insects may be included in their diet. They seem to take them as readily as they do other foods.

Assuming that this particular animal may have been merely collecting what it had no intention of eating or that hamsters may eat insects only when nothing else is available, further tests were made. Live moths, cockroaches, etc., were placed in a roomy glassed-in cage and hamsters of different ages and sexes were introduced singly. Other standard foods such as Purina Dog Chow, oranges and carrots were also available. All of the animals had had normal feeding up to the time of the tests. Four of the six animals tested ate one or more insects. Two females with young were included and they took the insects much more readily than did the others. They hunted them out and pounced on them, whereas the other animals took them only when the insects crossed their paths. This is in keeping with other data which suggest that females with young become quite carnivorous in the wild in order to satisfy their need for a high protein diet. They may well become predatory on other small rodents as well as insects, etc. Females will eat part or all of their own brood whether the young are one or eight days old if the diet is deficient in protein (preferably raw meat). Nursing females have on a number of occasions killed and eaten other young hamsters, some as old as seven weeks, when they have accidentally come together. Hamsters greedily eat whole small fish as well as any other kind of raw meat. They will also eat seeds, fruits, fleshy plant parts, any prepared food materials that have been offered, milk, water; in fact, almost anything that is at least partially digestible.—Don L. Jacobs, *Department of Botany, University of Minnesota, Minneapolis, Minnesota.*

PARASITES COLLECTED FROM WOOD MOUSE IN WEST VIRGINIA

During the past four years the collection of a series of 380 specimens of *Peromyscus leucopus noveboracensis* Fischer in various parts of West Virginia has resulted in the accumulation of rather interesting data upon its parasites. By far the greater number of consortes were ectoparasites; only occasionally was an endoparasite found. With the exception of *Cuterebra*, the season of the year had but little influence upon the population of ectoparasites.

Coleoptera: *Leptinus testaceus* Mueller is occasionally found in the nests of this rodent. It is here considered as a commensal rather than a parasite. It is quite probable that it is carried by the host from place to place.

Siphonaptera: *Peromyscopsylla hesperomys* (Baker). Collected in Hardy, and Mingo Counties. Common.

Orchopeas leucopus (Baker). Collected in Hardy, Grant, Pocahontas, Wyoming, and Wayne counties. Very common.

Epitedia wenmanni (Rothschild). Collected only in Hardy County.

Diptera: *Cuterebra* sp. An increase in the percentage of occurrence of this parasite is usually coincident with a low population of deer mice. For the past four years the population of deer mice in Hardy County has remained more or less stable and the number of *Cuterebra* found has been very small. Of 142 specimens of *Peromyscus* collected in this county only 8 percent were infected with *Cuterebra*. This same condition was found to exist in Mingo, Wayne, and Wyoming counties in 1941. Generally the full grown larvae are found in the inguinal region or on the back.

Arachnidea: *Ixodes* sp. Monongalia County. Rarely found.

Liponyssus sp. Hardy County. Commonly found infesting the ear.

Neoschöngastia brevipes Ewing. Hardy and Monongalia counties. Infestations of this species or *Liponyssus* are often so heavy as to disfigure the ear.

Atricholaelaps glasgowi (Ewing). Hardy and Monongalia counties.

Nematoda: *Rictularia* sp. Hardy County. Of 130 stomachs examined from specimens collected in Hardy County, only 10 percent were found to be infected.—L. WAYNE WILSON, *Moorefield, West Virginia.*

RECENT LITERATURE

(Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters)

[Reprints of this section may be purchased from the Corresponding Secretary]

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NEWS AND COMMENT

FIELD INVESTIGATIONS

Mr. J. Kenneth Doutt, Curator of Mammals, Carnegie Institute, Pittsburgh, Penna., left for a field trip on March 18 for Hudson Bay, via Air Lines Company plane equipped with skiis. He plans to return in September.

Dr. Wm. H. Burt, Curator of Mammals, Museum of Zoology, University of Michigan, Ann Arbor, Mich., left on a field trip to Mexico on April 7, where he expects to stay about three months.

PROGRAM OF THE FISH AND WILDLIFE SERVICE FOR STUDY OF EFFECTS OF DDT APPLICATIONS ON WILDLIFE

During the past three years there has been expanding use of the organic chemical DDT for the control of insects responsible for sickness and discomfort among our Armed Forces. This has been so successful that widespread interest has arisen in its possible use for the control of other insects, and experimental beginnings have been made to determine its value for control of crop and forest insects.

Up to now little knowledge is available as to what harm may be done to wildlife should DDT be applied on a large scale, but plans have been formulated to obtain needed information. The purpose of this statement is to acquaint interested individuals and organizations with these plans so that all concerned may know what steps have been taken to get the facts on this timely conservation problem.

This spring DDT will be applied experimentally by the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture to several forest areas, chiefly in the Northeast. Fish and Wildlife Service personnel will conduct detailed investigations on these sprayed areas during the spring in cooperation with the Bureau of Entomology and Plant Quarantine to determine the direct and indirect effects of the applications on wildlife. Entomologists of the Bureau of Entomology and Plant Quarantine will make studies on the effects of this new insecticide on the insect fauna as a whole. The experimental spraying will be on a scale sufficiently large to permit drawing conclusions that will apply should DDT be used in operational insect control.

Although preliminary studies seem to indicate that few, if any, birds and mammals are likely to be killed by DDT itself, indirect harm may come through reduction in insect-food supplies, especially when applications are made shortly before or during the nesting season. DDT is a relatively stable compound that is insoluble in water. Under forest conditions a single low-concentration application (in oil) for prolonged periods has continued to kill insects that have come in contact with the minute crystals that form after the solvent has evaporated, thus bringing about a prolonged reduction in the total insect population. Applications of DDT made from aircraft at the rate of 5 pounds per acre have killed amphibians and fishes either directly or through their taking poisoned food. The effect of DDT on these groups at different rates of application will be investigated under a variety of field conditions.

Experiments to determine levels of chronic and acute poisoning from DDT taken internally by bobwhites, mallards, various species of small rodents, mice, rabbits, fish, and other cold-blooded vertebrates are now in progress in Fish and Wildlife Service Laboratories.

The results of the field and laboratory studies planned for this year will indicate whether the use of DDT for the control of pest insects is hazardous to wildlife. The results will also serve as a guide to the Bureau of Entomology and Plant Quarantine in developing formulae, dosages, and methods of application that avoid hazards to wildlife and other beneficial forms of life.

GUNTER ACCEPTS NEW POSITION

On January 1, 1945, Dr. Gordon Gunter, who for the past 5½ years has been Marine Biologist for the Texas Game, Fish and Oyster Commission, was appointed Research Associate in the newly established Institute of Marine Science, of the University of Texas.

OBITUARY NOTICE

MILO HERRICK SPAULDING

1879–1945

Milo Herrick Spaulding, a charter member of the American Society of Mammalogists, died on Easter Sunday, April 1, 1945, at Bozeman, Montana, after a prolonged illness. He was born June 10, 1879, at Rutland, Vermont. He received the A.B. degree from Leland Stanford Jr. University in 1903 and the M.A. in 1906.

Professor Spaulding served as field assistant for the U. S. Bureau of Fisheries in Alaska in 1903, as assistant naturalist on the U. S. B. F. steamer Albatross in 1904 and as resident naturalist at the Gulf Biological Station in Louisiana from 1906 to 1908. In 1908 he went to Montana State College as Assistant Professor of Zoology and later became Professor of Zoology and head of the department.

His chief interests were in mammalian anatomy and embryology and after a year at Johns Hopkins in 1919–1920 he made a notable contribution to the latter field in his study on the development of the external genitalia in the human embryo. He was a member of Sigma Xi, Phi Kappa Phi, Phi Sigma and of many of the technical societies in his field.

Professor Spaulding's greatest characteristic was the sincere desire to be of help to someone else. He carried this to such an extent that it interfered seriously with his own research. It was this same trait, however, that made him so beloved as a teacher. Two generations of students will long keep his memory green.—C. A. Tryon, Jr.